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THE NEW WORKS OF THE MILWAUKEE GAS LIGHT CO.

Gas engineering is a special branch of the profession which is taken up by a somewhat limited number of engineers, and there is comparatively little current technical literature dealing with the manufacture of gas. In recent numbers we have described gas-holder construction and some forms of retort charging machines, and we are now able to present a full description of a large new gas-making plant which is thoroughly modern in design and equipment, and which includes a number of special features of particular interest. For the general information of those not versed in this branch of industrial engineering we have described the several processes and stages of manufacture as well as the special features in the design and construction of the plant.

The plant in question is that of the Milwaukee Gas Light Co., of Milwaukee, Wis. It is located in the Menomonee Valley, in the western part of the city, on a site having an area of about 23 acres and a frontage of 2,100 ft. on what is known as the Menomonee Canal, which is simply a straightened portion of the river, the gas work being built partly over the old river bed. The canal is 140 ft. wide, with bulkhead walls on each side, and a depth of about 21 ft. of water. The plant was designed by Mr. Rezeau B. Brown, chief engineer of the company. To Mr. Brown and Mr. R. C. Cornish, assistant engineer, we are indebted for plans and photographs and for much information furnished during a recent visit to the works.

When the plant is running at its full capacity it can make about 4,500,000 cu. ft. of gas per day of 24 hours, and to do that it will carbonize over 450 tons of coal. In a report by Mr. R. B. Brown, it is pointed out that all operations are performed by machinery:

> The coal is hoisted off the storage pile or from the boat by steam. It is loaded into cars by gravity, and carried to the retort house by compressed air locomotives. It is then fed by gravity into the electrically driven crushers, elevated by McCaslin conveyors, and dumped into an elevated bin. From this it is fed by gravity into the hopper of the charging machine, and then into the charging scoop. It is thrust into the retorts by electricity. The coke is drawn out by a compressed air machine, and falls into an electrically driven conveyor, which dumps it into a bin. From this it is delivered by gravity into buckets, which are hauled to the coke yard by the compressed air locomotives. Here it is hoisted either on to the storage pile or into the screen house by electricity, where it is passed through electrically driven screens and falls into the different bins, from which it is discharged by gravity for loading into sacks or into cars or wagons.

The company has on the east side of the city a water-gas plant of 3,500,000 cu. ft. daily capacity. This gas, together with 1,500,000 cu. ft. of gas from the Semet-Solvay by-product coke oven plant of the Milwaukee Coke & Gas Co., is (after purification) pumped to the new plant and mixed with the coal gas in the gas-holders.

BUILDINGS.

The site is partly an old river bed, as already noted, and heavy pile and concrete foundations were required to carry the loads of the benches and machinery. The principal buildings are as follows, and the dotted lines on the plan show the provision for a future duplication of the retort house and condenser house in symmetrical relation to the present plant:

FIG. 1. VIEW OF THE NEW WORKS OF THE MILWAUKEE GAS LIGHT CO.

Retort house	345 x 75 ft.
Condenser house	80 x 60 "
Power house	250 x 50 "
Purifier house	220 x 95 "
Office and laboratory building	140 x 40 "
Coke house	200 x 25 "
Gas pumping station (booster system)	78 x 45 "

A general plan of the entire plant is shown in Fig. 2 and a view looking west from the coal conveyor bridges is given in Fig. 1. In this the retort house is at the right, and next to it the machine shop, connected to the retort house by a bridge or passageway, by which the charging and drawing machines are transferred to the shop or house as required. Beyond the machine shop is the hot-coke bin, and then the power house, with a smokestack and a tower for the tanks. Beyond this (but hidden from view) is the office building, while to the right is the smaller of the two gas gas-holders, and to the left is the purifier house, behind which may be seen the coke conveyor bridge. The timber platform in the foreground is for the coal piles.

The main buildings are of steel frame construction, with brick walls and tile rooms, and some attention was paid to their architectural design, so that they are of more pleasing appearance than many buildings of this class. An elevated water tank was, of course, required, but the octagonal tower was incorporated with the power house and enclosed with brick walls and a tile roof, making it one of the architectural features. There are ammonia and acid tanks on the second floor of this tower, and a 48,000-gallon water tank, 8 x 32 ft. diameter, on the top floor; the other floors are used for storage. As the plant is shut off from the streets by the tracks of the Chicago, Milwaukee & St. Paul Ry., a viaduct with incline approach has been built across the railway at the west end, while a foot bridge (carrying the main pipes to the gas-holders) runs from the office building across the tracks. There is a complete sewerage system, and filtered river water is used for washing, and general purposes, while city water is used for drinking purposes and boiler feed. The structural steel work of the buildings, the charging and drawing machines and the two gas-holders, were all built by the Riter-Conley Mfg. Co., of Pittsburg, Pa. The plant is served by an industrial railway (termed the Menomonee Valley Ry.), which has about 1¼ miles of 30-in. gage, and handles all the coal, coke and boiler fuel, as well as the ashes from the boiler room and retort house. Its equipment includes two Porter four-wheel compressed air locomotives (1,000 lbs. receiver pressure), six coal dump cars, six boiler fuel cars and eight flat cars, four of which are for handling the coke buckets.

COAL.

The coal used is what is known as Youghiogheny, or Pittsburg, gas coal, which contains a large percentage of volatile matter (gas) and a small percentage of ash and sulphur, while it produces a good grade of commercial coke, amounting to about 65% of the original weight of the coal. The average analysis of the coal is as follows:

Volatile matter	35.5%
Fixed carbon	59.0%
Ash	5.5%
	100.0%
Sulphur	1.1%
Heat value	14,100 B. T. U.

COAL STORAGE AND COAL HANDLING MACHINERY.

The coal is brought from Lake Erie ports by large steamers, which usually carry about 7,000 tons, and these lie alongside of the company's coal storage yard, which is about 600 ft. long

and 330 ft. wide, with a total storage capacity of about 125,000 tons. The dock is of timber construction, with a bulkhead wall securely anchored by tie rods and timbers in order to withstand the thrust due to the coal piles. Along the coal dock is a track for the towers of three Brown hoisting machines, each having a conveyor bridge 312 ft. long, supported by a tail tower, or shear leg, at the opposite side of the yard, where there is also a side track for coal cars. The hoisting is done by steam power, but there are electric motors for moving the towers and for raising and lowering the boom, or apron. The conveyor bridge is pivoted to the towers, so that the main tower on the dock can move 20 ft. without requiring the shear leg to be moved; swing-jointed steam pipe connections to the 8-in. steam main laid along the dock are provided at 20-ft. intervals.

The coal is raised from the vessel's hold by a clamshell bucket of 84 cu. ft. (2 tons) capacity, which dumps its contents into a receiving hopper at the head of the boom, from which it is delivered by gravity into a 3½-ton bucket, or tub, which is carried by a trolley on the conveyor bridge and dumped at any desired point on the coal pile. By this arrangement the clamshell bucket can work steadily to unload the boat and fill the hopper, without having to make a trip along the conveyor bridge to the coal pile. This increases the speed with which the boat can be unloaded. With the three machines in use, a cargo of 7,500 tons has been unloaded in 23½ working hours; this makes an average of nearly 106 tons per hour for each machine, including the time of cleaning out the coal from the bow and from under the boilers, etc.

The coal for the retorts is picked up from the pile either by a 2-ton clamshell bucket or by a 2½-ton shovel bucket which is dragged along the pile and scoops up its load. These are suspended from the trolley of the conveyor bridge, and when filled they are raised high enough to clear the pile and carried forward to be dumped into a stationary bin, or hopper, from which the coal is loaded into the 6-ton dump cars which are hauled over the industrial tracks to the retort house by the compressed air locomotives.

At the retort house the cars dump the coal into the hoppers of West crushers, having two sets of rolls, to reduce the coal to a 2-in. size, ready for the retorts. These hoppers and crushers are set in a pit 16 ft. beneath the floor. From the crushers the coal falls into a McCaslin continuous bucket conveyor, which passes up the south wall of the building, across two large storage bins at the middle of the building and then down the opposite side to return to the crusher pit. There are two crushers, each driven by a 20-HP. motor; and two conveyors, each with a 15-HP. motor. Each crusher with its conveyor can handle enough coal during the day to run the entire retort house for 24 hours, but ordinarily they are both run together until the necessary amount of coal has been delivered to the two bins. These bins have a capacity of 600 tons of coal, and extend across the middle of the retort house, at a sufficient height to allow the charging and drawing machines to pass beneath.

BENCHES AND RETORTS.

The retort house has a height of 45 ft. from the charging floor to the eaves, and this, with the large exhaust ventilators, causes a strong draft for carrying off the smoke. Steel columns carry the roof trusses and the framing for the charging floors, the brick walls carrying only their own weight. Down the middle of the building are placed the furnaces. There are 48 benches, each with eight retorts and a furnace, and these are arranged in two stacks or batteries of 24 benches each. The stacks are double, with benches back to back, the two stacks being separated by a transverse passageway beneath the coal bins. Fig. 3 is an elevation of one bench, with its furnace, charging and cleaning doors, retort mouthpieces and ascension pipes.

There are eight retorts to each bench, arranged in two vertical rows, as shown in Fig. 4, which also shows two of the vertical smokestacks from the benches and the steel pipe of the hydraulic main along the top of the benches. Fig. 5 is a view of one completed "stack," or battery of benches. The retorts are of fire-clay, of the modified D section, with the flat side down; they are 26 x 16 ins. inside, and 3 ins. thick, except that at the front end the thickness is 4 ins. to give strength enough to support the iron mouthpiece and lid. Both single and through retorts are used; the former are 9 ft. 4½ ins. long, closed at the back. The latter are a little more than twice this length and have a mouthpiece at each end. They carbonize more coal and are much more economical than the single retorts. The charge for each retort is from 400 to 450 lbs., and the retorts are "drawn" and recharged every five hours. When a retort becomes coated with a crust of carbon it is cleaned by burning this off; for this purpose the mouthpiece door is left open, and a piece of tile laid on the bottom to carry the draft of air into the redhot retort. The draft is induced by a steam inspirator set in the lower opening of the vertical stand-pipe attached to the mouthpiece. When the lids of the retorts are closed they are jammed tight by an eccentric fastening, operated by a hand on the hinged end (Fig. 5), so that no luting at the contact faces of the lid and mouthpiece is required.

The furnaces beneath the retorts are fired from the charging floor, through vertical chutes with round holes in front of the benches, as shown in Figs. 3 to 5. On the ground floor are doors for cleaning out the furnaces, the cinders being loaded into cars and largely used for filling. Coke is usually burned in these furnaces, except in winter, when the demand and price for coke are high and it is cheaper to use coal for fuel. The temperature in the combustion chamber and around the retorts is 2,500° to 2,700° F. There is a 30-in. smokestack for each eight benches, and these extend to the roof ventilators, giving a stronger draft than if each bench had a separate smokestack.

DRAWING AND CHARGING THE RETORTS.

When one row of retorts has been fired for five hours and is ready to be drawn, the doors of the first two or three are opened, the entrance of air mixing with the gas in the retort then causing a great burst of flame unless the gas has been touched off with a torch before the door is pulled wide open. The drawing machine runs on a track on the charging floor and has a long rake or hoe, which can be given both a reciprocating motion and a vertical motion. This machine is operated by compressed air, at 125 lbs. pressure, piped from the power house to the retort house, where a long flexible hose is connected to the air pipe and the machine. All the motions are controlled by levers handled by the operator on the machine, and when it is run in front of a retort a few strokes of the rake suffice to pull out the incandescent coke, which falls into a conveyor below the level of the floor, as described more fully later on. Directly behind this comes the charging machine, which is operated by electricity. On the top of this is a hopper, fed from the bin in the roof of the retort house, and holding coal sufficient to charge about 20 retorts. This hopper has a long, narrow opening at the bottom, and beneath this is a scoop, or trough, about 9 ft. long, holding a charge for one retort. By opening a gate at the bottom of the hopper this scoop is filled with coal; it is then thrust into the retort, inverted and withdrawn, leaving an even bed of coal along the entire length of the retort. The machine then moves on, and the door is at once closed. The scoop can be raised or lowered to the level of any tier of retorts. These machines are of the West type, and there are two charging and two drawing machines in regular service, one on each side of the house. An extra machine of each kind is kept in reserve for an emergency. For convenience in making repairs the machine can be run through a passageway to an elevated floor at the end of the

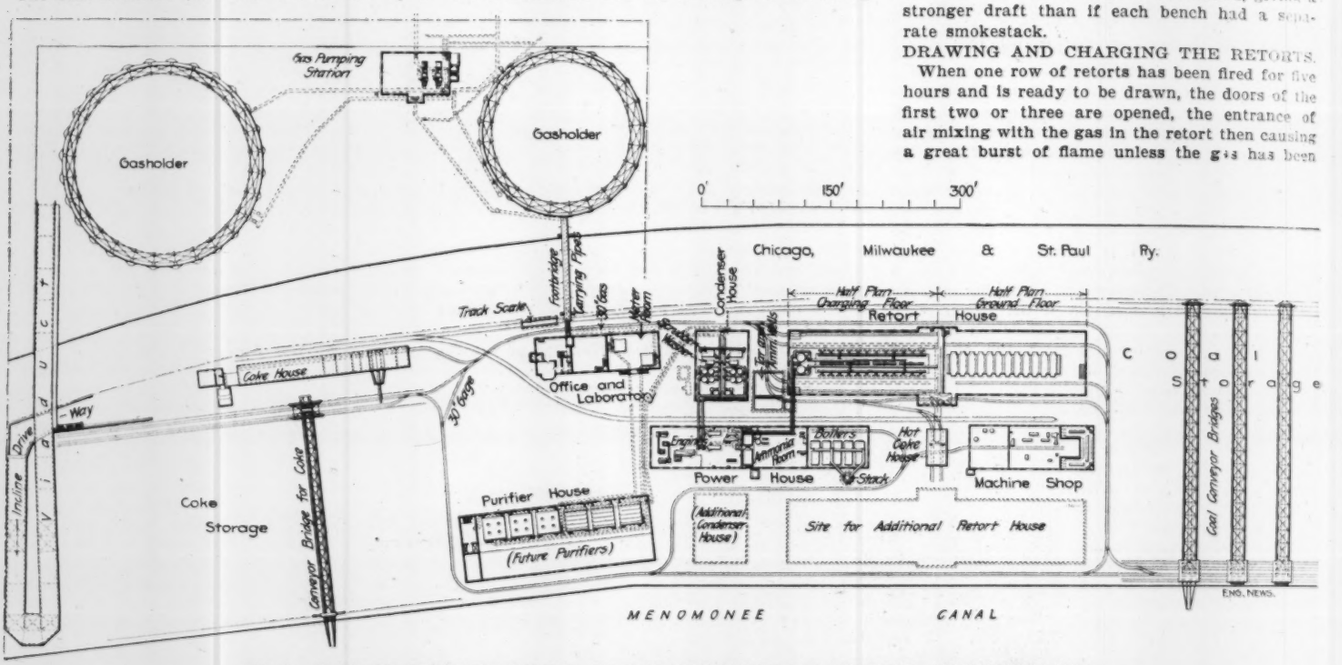


FIG. 2. PLAN OF THE NEW WORKS OF THE MILWAUKEE GAS LIGHT CO., MILWAUKEE, WIS.

machine shop, where the reserve machines are placed. Fig. 6 shows a pair of these machines.

COLLECTING THE GAS AND OTHER PRODUCTS.

The gas generated in each retort passes through a vertical ascension pipe, or standpipe, attached to the mouthpiece, then through a horizontal bridge pipe and down through a vertical dip pipe into the hydraulic main. This main (shown above the benches in Fig. 4) is a large horizontal steel pipe of D section, 30 x 30 ins. (with the flat side on top), supported above the benches and a little distance back from the row of standpipes. It is about half full of water or ammoniacal liquor, and the open lower ends of the dip pipes dip about ¾ in. into this liquid; the gas bubbles up through the liquor and collects in the upper part of the main, the liquor forming a seal to prevent its return to the pipes when the retorts are opened.

The gas leaving the retorts is accompanied by the following impurities, in greater or less amounts: Hydrocarbon vapors, or tar; ammonia, carbon dioxide, sulphuretted hydrogen and other sulphur compounds, besides a considerable quantity of watery vapor. While some deposit of tar takes place in the ascension pipes, the first real condensation is in the hydraulic main, where part of the tar condenses and settles to the bottom; a large part of the watery vapor also condenses and settles, taking up some of the ammonia and other impurities, and forming what is called ammoniacal, or gas, liquor. There is a constant flow of this liquor through the hydraulic mains, being maintained by a circulating pump in the power house. This pump takes the liquor from a small well and forces it through pipes to the head of the main, into which it is discharged with considerable velocity from a number of jets near the bottom. At the other end of the main the liquor flows over an adjustable overflow, by which the level of the liquor in the main (and consequently the depth of immersion of the dip pipes) is regulated. Thence it again flows to the pump well. The flow of liquor washes the tar along the bottom of the main to the discharge end, where it passes out over a separate overflow and runs to the tar well. The liquor and tar wells are of concrete, placed underground, and having capacities of 70,000 and 33,000 gallons, respectively.

CONDENSERS, WASHERS AND SCRUBBERS.

The temperature of the gas as it leaves the retorts is from 600° to 900° F., and by the time it leaves the hydraulic main this has been lowered to about 150° F. From these mains there are two distinct lines of pipe all through the works, one from each stack of benches, so that the gas from each stack can be treated separately through all the various processes until it reaches the station meters, while by-pass valves and connections enable the two streams of gas to be united and mixed at any desired point. Most of this piping has flanged and bolted joints, but lead joints are used where possible.

The gas collecting in the top of the hydraulic main passes first through a 24-in. riveted steel "foul main," which has a connection for every six benches, and conveys the gas to the primary or air condenser (one for each line of pipe). This consists of a vertical cylinder, 10 ft. diameter and 33 ft. high, containing a number of 16-in. tubes, open at each end. Cold air enters at the bottom and passes out at the top of the tubes, while the gas enters at the top of the cylinder and passes out at the bottom. This first cooling reduces the temperature of the gas to about 120° F.

Beyond each condenser is an exhauster of the positive type, which draws off the gas from the hydraulic main through the air condenser and delivers it at sufficient pressure to force it through the rest of the condensing and purifying apparatus on its way to the gas-holder. In order to prevent back pressure on the retorts it is necessary to maintain a slight vacuum in the hydraulic main, and, as the rapidity with which the gas is generated varies very materially, the exhausters are fitted with governors, which so regulate the speed of their engines that a constant rate of vacuum is maintained at the inlet, whatever may be the quantity of gas generated.

The gas from the exhauster is delivered to the condenser house, where it is first passed through a tar extractor of the "P. & A." type; this has sheet iron screens, with the openings so placed that the jets of gas passing through the first screen impinge upon the solid parts of the second screen; the tar held in suspension in the gas is deposited on this surface and runs down to a collecting chamber, from which it passes by an automatic overflow to the tar well. From the tar extractor the gas next passes to one of two batteries of water-cooled condensers, each consisting of four condensers, similar to the air condensers, but having a circulation of water upward through the tubes. These condensers are about 6 ft. diameter and 22 ft. high, with 2½-in. tubes. They are so connected that the gas can be run through different groups, as may be required. The temperature of the gas entering the condensers varies from about 95° or 100° F. in winter to as high as 120° F. in summer, depending upon the atmospheric conditions and also upon the amount of gas made. The temperature is reduced to about 60° at the outlet.

The impurities remaining in the gas after passing the condensers are ammonia, carbonic acid, sulphuretted hydrogen and other sulphur compounds. Every effort is made to remove all traces of ammonia, as it not only has a commercial value, but if left in the gas it would burn to objectionable compounds, and is said to have an injurious effect upon brass or copper work with which it may come in contact, such as meters, gas fittings, etc. Under ordinary conditions of temperature and pressure, ammonia is a gas, but it is extremely soluble in water, one part (by volume) of water absorbing from 500 to 800 parts of ammonia. This property is taken advantage of in separating the ammonia from the gas, and in both the washer and scrubber the gas is brought into contact with water or weak ammoniacal liquor.

In the washer the gas is forced up through the liquor, which removes part of the ammonia and the last traces of tar. It then passes to the scrubber, which is of the mechanical type, consisting of a long, horizontal cylinder, containing revolving disk brushes, which dip into the weak liquor in the lower part of the cylindrical vessel. The gas in the upper part of the vessel passes through the brushes and comes in contact with a very large area of freshly wetted surface, the moisture on which absorbs the ammonia. A stream of clean water enters one end of the scrubber and flows from the other end as weak liquor, which is delivered to the ammonia well. At present no effort is made to recover the cyanide, but space is provided for a plant for this purpose next to the scrubbers.

During the process of washing and scrubbing, the ammonia in the liquor unites with and thus removes part of the sulphuretted hydrogen and carbonic acid contained in the gas, thus relieving the work of the purifiers, through which the gas is next passed. This weak liquor, together with the water condensed from the gas in the condensers and hydraulic main, form the crude gas liquor, the ammonia being in the form of many different compounds.

PURIFIERS.

From the condenser house the gas is piped underground to the purifier house, Fig. 7, where it undergoes its final treatment, which is for the removal of the sulphuretted hydrogen. This consists in passing the gas through a series of beds of iron oxide, mixed with wood shavings. The shavings serve to support the oxide and to make the mass porous for the easy passage of the gas. When the foul or unpurified gas comes in contact with the iron oxide, the latter breaks up, the iron uniting with the sulphur of the sulphuretted hydrogen, and the hydrogen and oxygen uniting to form water. When the material of the beds has become foul and ceases to absorb sulphur, it is treated by a revivification process. It is removed and spread on a floor and turned over with shovels to expose it to the air, and through the action of the air the iron is re-oxidized, taking up oxygen from the air and depositing free sulphur. In this way the purifying material can be used over and over again until it contains over 50% of sulphur. It is then worthless as a purifier, but has a commercial value, being sold for the recovery of cyanogen.

The purifier house has two floors, the lower one

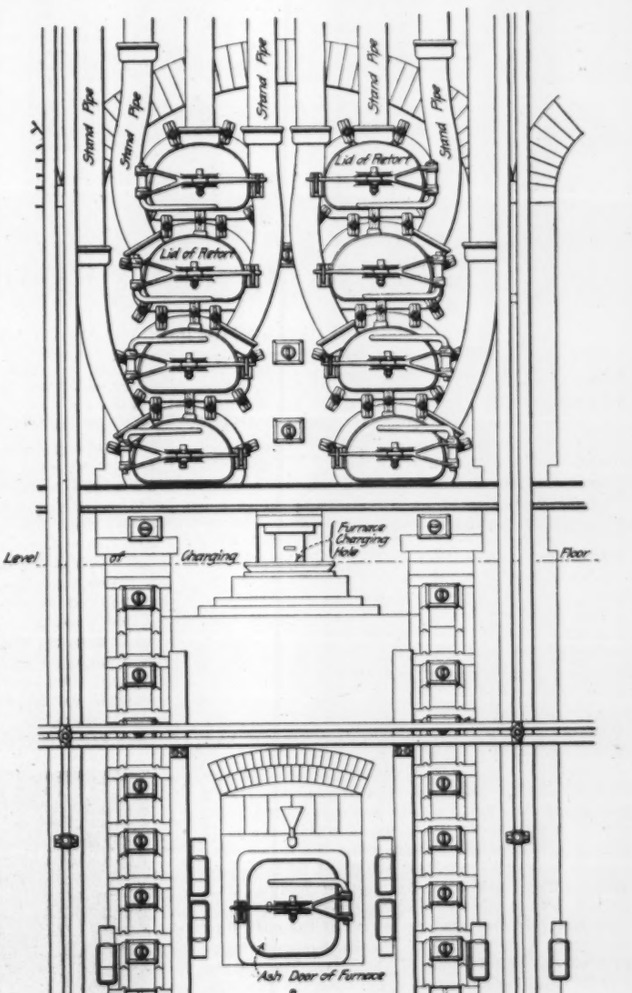


FIG. 3. ELEVATION OF ONE BENCH IN RETORT HOUSE.

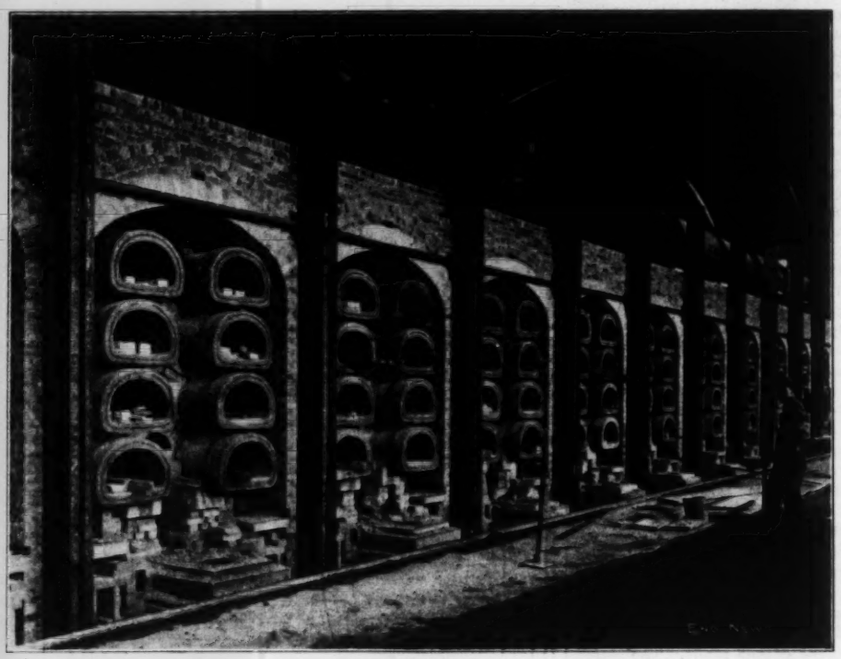


FIG. 4. RETORTS READY FOR IRON MOUTHPIECE FITTINGS.
(Above the row of benches is the steel hydraulic main.)

being of concrete and used for the first mixing and subsequent revivification of the material for the beds. Through openings along the middle of this floor the material is shoveled into a conveyor, which passes up one end of the building and returns along the roof, dumping the material into the bins above the upper floor, from which it is drawn by spouts to fill the boxes. The exposed ironwork in this building is painted with the Goheen carbonizing coating as a protection against corrosion by the sulphur fumes, while the bases of the columns are encased in concrete for a height of about 3 ft., as the purifying material is piled on this floor and surrounds the columns.

The upper floor contains six purifying boxes (three for each line of gas) and has space for six additional boxes. These are of cast iron, 26 ft. square and 11½ ft. deep; they have heavy covers, fitted with a dry (rubber) seal, in preference to a water seal (being made to withstand a pressure that would blow a 30-in. water seal), and are handled by an overhead traveling crane. Each box has in the bottom four dump openings, from which hang chutes, the tops of which are level with the bottom of the box, while the lower ends project below the box and are fitted with bottom gates. There are also drain pipes leading to a trap to collect the water of condensation.

In each box are two 5-ft. layers of the purifying material, with 6-in. gas spaces between them and at top and bottom of the box. The valves and connections are so arranged that the gas may be either admitted to the middle space (passing through the material to the top and bottom spaces), or to the top and bottom spaces (passing through the material to the middle space). The gas is passed through three boxes in succession until the first one becomes foul. This box is then cut out, the cover raised, and the material shoveled through the discharge chute to the floor below. When the upper bed has been removed in this way the portable top section of the chute is lifted off by the crane, and the lower bed removed in the same way. A charge of fresh material is then put in, the cover set in place, and the gas again turned on. This box is then made the last of the series, the gas being always passed through the foulest box first.

METERS AND GAS PUMPING PLANT.

The gas from the purifiers is the finished product and is delivered to the meter room, which has two station meters, 14 ft. diameter, each capable of taking care of about 150,000 cu. ft. of gas per hour. From these it goes to the gas-holders and from them to a pumping station containing two Root blowers, each direct-connected to a Nash vertical gas engine of 100 HP. These deliver the gas to the "booster" mains at a pressure of from 5 to 60 ins. of water. The engines and blowers are only put in use at the hours when the consumption requires increased pressure, and the speed of the engine is varied according to the consumption. For the evening "peak," when lights and stoves are going into use throughout the city, a pencil line, showing the required increase and decrease of pressure for this period, is laid out on the chart of a recording gage, and the operator regulates the engine speed so as to cause the pen of the gage to follow this line. Space is provided for two additional station meters and blowers when the plant is enlarged. The pumping station and gas-holders are separated from the rest of the work by the railway tracks, and the pipes from the meter house are carried across the tracks on a footbridge.

GAS-HOLDERS.

There are two gas-holders, one of which is the largest in the country, except those now being built at Astoria, N. Y., for the supply of New York City; there are also several larger ones in England. Both of the Milwaukee gas-holders have steel tanks, on pile and concrete foundations. For the erection a revolving traveler, or erection crane, was used. Three horizontal latticed girders, one above the other (with the upper one about 75 ft. above the ground, revolved around a pivot on a tower at the middle of the tank, with the outer end of each girder supported by a bent running on wheels on a track inside the circumference of the tank. Each bent formed the base of a vertical steel A-frame, 145 ft. high, having near the top a crosspiece to support the heel of a hoisting boom of 15 tons capacity. This erecting traveler was very similar to the one described in the article on the New York gas-holders in our issue of Oct. 26, 1905. The dimensions of the two Milwaukee gas-holders are as follows:

Diam. of tank	225 ft. 9 ins.	184 ft. 0 ins.
Diam. of shells	216 to 222 ft.	137 ft. 2 ins. to 180 ft. 9 ins.
Height when extended	210 ft.	166 ft.
No. of telescopic sections	Five	Four
Gas storage capacity	6,000,000 cu. ft.	3,000,000 cu. ft.
Water capacity of tank	10,000,000 galls.	6,500,000 galls.
Pressure caused by holder (ins. of water)	12.5	8.5

POWER PLANT.

The use of gas engines is one of the features of the power plant as well as of the gas pumping plant above described. The power house has the boiler room and engine room at opposite ends, and the ammonia room in the middle. For the air-compressors, etc., there are five Scotch boilers of 200 HP., and an interesting feature of the boiler plant is that coke breeze is used as fuel. This is burned in firebrick furnaces using forced draft. These are of special design and are shown in Fig. 8. They are fitted with the White hollow grate bars, with curved top surfaces, the air escaping through slots across the tops of the bars. Short flues lead from the furnaces to the boilers, and the smoke flues lead to a brick chimney 125 ft. high, of 5½ ft. inside diameter.

The engine room contains a Westinghouse three-cylinder vertical gas engine of 300 HP., directly

FIG. 5. ROW OF COMPLETED BENCHES.

connected to a 150-KW. Westinghouse generator; and two Nash three-cylinder vertical gas engines of 125 HP., belted to two 75-KW. Bullock generators. The generators are all of the direct-current type, and this plant furnishes power for all the conveyors, coal crushers, coal and coke bridges, coke screens, charging machines, machine shop, and arc and incandescent lamps for lighting the plant. A three-stage Laidlaw-Dunn-Gordon air compressor supplies air at 1,000 lbs. pressure for the industrial locomotives; this is piped through the yards, where several connections are provided to enable the engines to be recharged conveniently. Two Brown-Cochran compressors (compound steam and two-stage air) supply air at 125 lbs. pressure for the drawing machines in the retort house. There are two Root rotary pumps for pumping water from the river into a tank on the sixth floor of the tower, from which it is piped through the works for fire protection, coke quenching toilet and wash rooms, etc. The water is so impregnated with free ammonia and chlorine from factories higher up the river that it cannot be used in the boilers, although a lime and filter treatment plant was designed and installed. The water for the boilers and for drinking purposes is taken from the city mains.

The ammonia room contains the still and the ammonia and tar pumps, drawing the supply from the collecting wells fed by the hydraulic main. There is also a machine designed and built at the works for mixing the cream of lime and pumping it to the ammonia recovery apparatus.

The machine shop employs about a dozen men and has a variety of repair work to perform, besides building coke buckets, cars, etc. Its equipment includes a planer, lathes, drill presses, pipe-threading machines and grinders, while at one end are a blacksmith shop and carpenter shop.

LABORATORY.

The office building contains a large chemical laboratory and photometric room, and extensive equipment of apparatus for gas analysis and experimental work. The gas has a normal illuminating value of 18 candles, and heating value of 650 B. T. U. An approximate value of average commercial gas (containing coal gas, benzol-enriched oven gas and carburetted water-gas) is as follows:

Carbon dioxide	CO_2	2.3
Oxygen	O_2	0.3
Carbon monoxide	CO	12.0
Benzine	C_6H_6	1.6
Other illuminants		9.0
Methane	CH_4	31.0
Hydrogen	H_2	41.5
Nitrogen	N_2	2.3
		100.0

The regular tests, made either in the laboratory of the new West Side works or at the Third Ward works, include the following: 1st, analyses of samples of each cargo of coal received to determine moisture, volatile matter, fixed carbon, ash, sulphur, B. T. U. per lb., and iron in the ash; 2d, determination of candle power, heating power, volumetric analyses, sulphur, ammonia, etc., in the various finished gases; 3d, determination of moisture, ash, sulphur and heating power of coke produced; 4th, fixed carbon and water in the tar produced; 5th, fixed carbon and viscosity of pitch; 6th, analyses of the distillate oils for naphthalene, etc., and, 7th, the strength of ammonia liquor in the wells and in the storage tanks of the concentrator.

Other work of this character includes the following: 8th, chimney-gas analysis and pyrometric tests for the regulation of the furnaces; 9th, tests of crude gas at different points to find the effect of condensing, washing, scrubbing and purifying in the various apparatus; 10th, routine tests of the 20 lots of oxide used in purifying the gas; 11th, tests of gas oil, fittings and other purchases; 12th, tests for control of by-product plant. Experimental work is also conducted on incandescent gas lamps and mantles and in various other directions.

COKE.

An important feature of the plant is the method of handling the large quantity of coke continually discharged from the retorts, and the method of emptying the retorts has already been described. In front of each row of benches is a steel pan conveyor, like an endless trough (with no cross-pieces), 18 ins. wide and 6 ins. deep. This is just below the charging floor and covered by a trap at each bench. As the incandescent coke is drawn from the retort it falls into this conveyor, which carries it to the middle of the building. Here it is delivered to a similar transverse conveyor running across the basement, at the opposite end of which it rises on an incline, and as the coke ascends it is quenched by a spray of water from a pipe. Each of the four main conveyors is operated by a 5-HP. motor, while each of the two lateral conveyors has a 10-HP. motor. The inclined end of the conveyor passes out of the building and enters the top of the hot coke bin, which is a steel framed structure, supported on columns and having concrete walls which enclose the steel work.

The coke is drawn from this through hoppers into steel coke buckets, or tubs, of 70 cu. ft. capacity, having drop bottoms. These are mounted on flat cars and hauled to the coke yard, where a single Brown hoist and conveying bridge, with electric trolley, operated by a man riding upon it, handles the buckets and dumps them onto a storage pile or delivers them directly to the screening house, which is of similar construction to the hot coke bin. The coke taken from the pile by a scraper bucket, or delivered direct from the hot coke buckets, is discharged into hoppers feeding two revolving screens driven by electric motors, which separate it into four sizes; three of these are for commercial use, while the fine dust or breeze is used as fuel for the boilers. About half of the coke is sold to water-gas plants and for manufacturing purposes, but there is also a large trade for domestic fuel. This coke, being treated in small lots, and for a short time, is more valuable for domestic purposes and some manufacturing purposes than by-product coke carbonized in large quantities and for a longer time. The coke from the bins is loaded by spouts into sacks on the ground floor or by chutes to wagons or railway cars.

FIG. 6. CHARGING AND DRAWING MACHINES FOR THE RETORT HOUSE; MILWAUKEE GAS LIGHT CO.

BY-PRODUCTS.

The principal by-product from the manufacture of gas is the coke. The method of handling this has already been described, as well as its disposal for boiler and domestic fuel, for water-gas plants and for manufacturing purposes. All of the tar is worked up at the company's North Milwaukee tar plant into paints, roof coatings, pitch, tar, macadam bitumens, creosote oil, etc. The heavy oil (or creosote) is sold to creosoting works for use in tie and timber preserving, while the lighter oils are being used in the manufacture of shingle stains and disinfectants which the company is now putting on the market.

The ammonia is distilled from the liquor (as noted in the description of the power house) and is sold in its crude form to the refiners and manufacturers of ammonia products. The waste material from the purifier beds (when charged with about 50% of sulphur) is sold to chemical works for the production of cyanogen (used in the manufacture of washing blue).

HIGH-PRESSURE GAS DISTRIBUTION SYSTEM.

From the gas-holders the gas is distributed at a pressure of 5 to 60 ins. into a system of "booster" mains serving the several districts into which the city is divided for distribution purposes. These "booster" mains in turn supply the general distribution system, the pressure in which is reduced to about 3 ins. by means of governors at the connections of the "booster" mains with the distribution system of each district. There are now in use a total of 350 miles of pipe, and about 20 miles of extensions are laid each year.

USES OF GAS.

The work of the company and its engineers does not end with the manufacture and delivery of the gas, and the utilization of by-products, but special work is undertaken to increase the field for the utilization of the gas. Thus a great deal has been done in improving lamps and burners, in introducing mantles, and also in introducing large gas-arc lamps for exterior lighting and for the interior lighting of factories, stores, etc., where electric arc lamps are commonly used. These gas-arc lamps have a much softer light than the electric lamp, and are very brilliant and steady. Much has also been done to develop the use of gas stoves for domestic cooking and heating purposes. Going beyond the ordinary field of lighting and heating, the company has developed the use of gas for power purposes, and supplies over 300 gas engines, aggregating about 3,200 HP. It has also succeeded in building up a large business in the supply of gas for manufacturing and industrial purposes, and much special apparatus in this line has been devised and invented in its own laboratory and industrial department. In many cases ordinary burners are used, but where a specially high temperature is required an air-blast burner is used. At the present

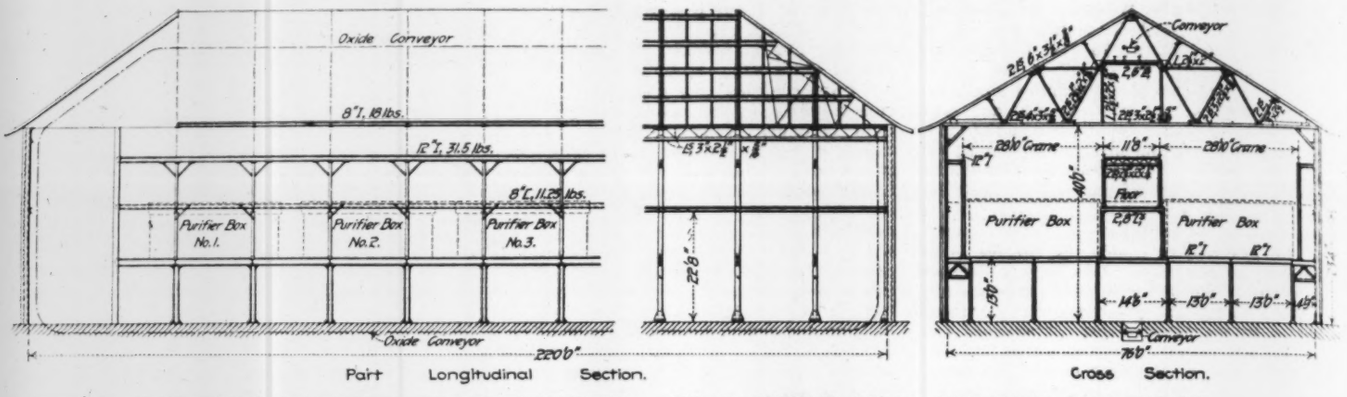
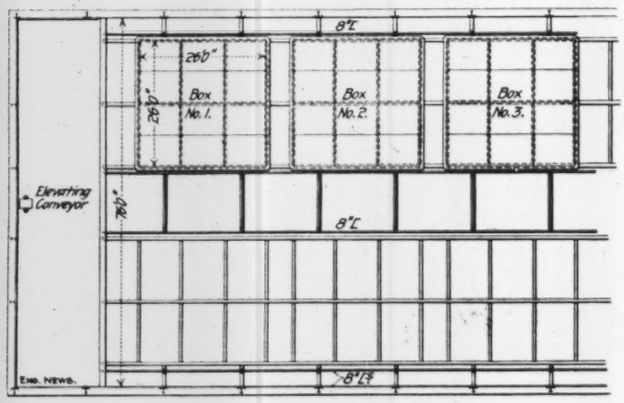


FIG. 7. PURIFIER HOUSE; MILWAUKEE GAS LIGHT CO.



time experiments are being made with a new design of annealing oven for stamped steel ware; this has a firebrick combustion chamber, through which the articles are passed by an endless conveyor, or traveling floor.

RETEMPERED MORTAR IN CONCRETE WORK.

By Ernest McCullough, C. E.*

An old English mason, full of trade secrets handed down for generations, undertook to tell the writer a lot about his work several times when in a mellow mood. He railed against a clause in the specifications that prevented the use of retempered or "regaged" mortar and swore it was the best kind. Experiments made on retempered mortar by several engineers have been severe, and, while there is a close agreement in the results, no reports of the value of a slightly retempered mortar seem to have been printed.

The old man mentioned was the only one the writer ever saw who could replace the surface of a damaged concrete sidewalk and make a good job. He said that roughness did not count. It was porosity, or, as he termed it, "a free biting surface," that was needed. He cleaned off the old surface thoroughly with a wire brush. Then he soaked it with a diluted acid wash. He mixed a batch of mortar to fill the space and allowed it to stand from one-half to three-quarters of an hour. Then he worked it again, adding a small amount of water from time to time. He said it was necessary to work it until he perspired, and it was work he did not intrust to the helper. When it was ready he put it in the space fairly wet and worked it harder and troweled it harder than is considered good practice by the run of concrete workers. None of the sidewalks he repaired flaked off, and oftentimes it was hard to find the place where the patch had been put in.

We had a job afterwards where new concrete had to be joined to old concrete. A portion of the wall had been built several months and work had been stopped because of legal difficulties. Several times portions of the work had to be done again, as it was difficult to get a satisfactory joint. The old mason was sent for, and he took up his hobby, "retempered mortar," and made a satisfactory joint. He told us the first mixing got the cement fairly well distributed through the mortar, but the standing tended to separate the aggregates. The second working when it was tough made it slower setting, so it did not "pull away" from the other work. He also told us that it made it so slow to set that its insertion between old concrete already set and new fast-setting concrete made a flexible joint. The writer has tried it several times since and obtained excellent results. If the retempering proceeds so far that the adhesive qualities of the mortar are impaired the addition of from 10 to 12% of lime restores it. All of which is now text-book information.

In the erection of buildings made of concrete blocks much difficulty is experienced with the mortar. In fact, the worst looking part of a concrete blockhouse is in the joints. Cement mortar does not take good hold, and lime mortar causes a disagreeable efflorescence. The writer the past year made a few experiments with ordinary cement mortar, ordinary lime mortar, lime mortar containing cement and cement mortar containing lime. Building blocks were laid up in the different mortars, and after a few months taken down. When the mortar contained more than 15% of lime the blocks were discolored, and it was a comparatively easy job to pry them apart. Retempered mortar without lime made a stronger joint than ordinary cement mortar without lime, but no stronger than ordinary mortar containing less than 10% of lime. Retempered mortar containing from 10 to 15% of lime made a remarkably strong joint.

The experiments were made solely as a guide to indicate the line along which to work, and the results obtained were not tabulated in a form usual with more academic work of this nature. The blocks were simply pried apart. The writer has commenced a new series of tests to determine absolutely the adhesive qualities of retempered mortar and to determine whether its supposed value is an idea of an old-school mason or if it is really worth looking into. So far he judges it has a real value, especially in joining old work to new.

In considering retempered mortar he does not mean mortar allowed to set several hours and retempered at intervals of half an hour, such as discussed in several recent books. The retempered mortar he means is mortar allowed to stand until the initial set seems to have been attained, then worked very thoroughly until plastic, water being added during the process if necessary. Such mortar shows an increase in strength of from 15 to 40% over plain mortar. That is, briquettes made from both batches show up stronger in the batch worked twice.

If the mortar is allowed to stand a length of six or eight hours and reworked at intervals of from one-half to three-quarters of an hour, there is a slight decrease of adhesive strength after the second working, and this is fairly constant with each working. That also is text-book information, and the writer's work confirms it.

The first retempering, therefore, seems to give additional strength, because of the increased amount of mixing performed before the mortar has set enough to get a fiber to be injured. The same result might be obtained by the same amount of work in the first place. That is, so

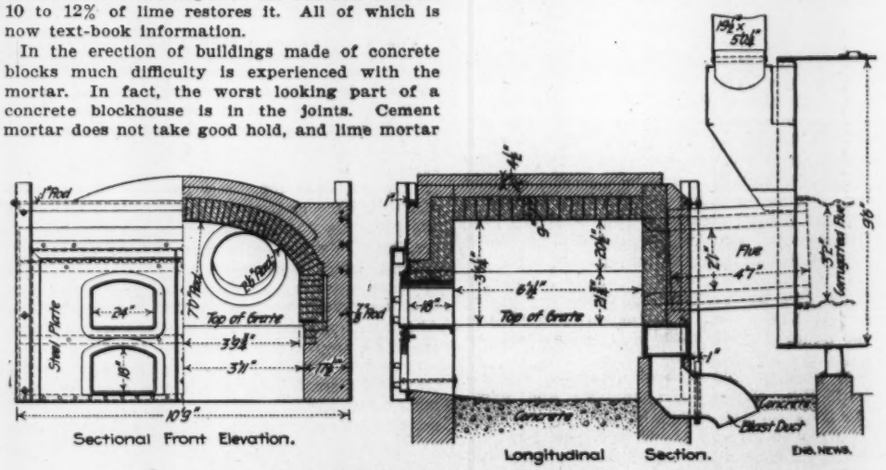


FIG. 8. FURNACE FOR BURNING COKE BREEZE FOR SCOTCH BOILERS.

*P. O. Box 691, Chicago, Ill.

far as strength alone is concerned. It is the slow setting, however, that gives retempered mortar its principal value.

The addition of a small amount of lime prevents too great shrinkage in setting. Retempered mortar, therefore, with a slight amount of lime seems to have a place as a material with which to patch and repair old concrete, as a mortar for building blocks, and as a material to interpose between old concrete surfaces and freshly deposited concrete to make a close junction.

WILLIAM THOMPSON SEDGWICK: PRESIDENT NEW ENGLAND WATER-WORKS ASSOCIATION.

The New England Water-Works Association did credit to itself, as well as to Prof. William T. Sedgwick, of the Massachusetts Institute of Technology, by electing the latter as its president on Jan. 10. Professor Sedgwick has long been a staunch supporter of the association and has taken no small part in the development and application of knowledge of pure water supplies, how to get them and how to keep them. He has also contributed largely to other branches of sanitary science, and, as will appear later, has had important connections with municipal and state civil service reform. In view of all the foregoing facts we take pleasure in presenting herewith a biographical sketch and portrait of this newly elected society president.

William Thompson Sedgwick was born in West Hartford, Conn., on December 29, 1855. He was the son of William and Ann (Thompson) Sedgwick, and a direct descendant of Robert Sedgwick, of Charlestown (Boston), Mass.. The latter was born in Woburn, England, in 1611, arrived in Boston in 1636-7, died in Jamaica, W. I., in 1656, after having been sent from Boston as Major General by Oliver Cromwell to command the British forces in Jamaica.

The subject of this sketch prepared for college at the Hartford high school, and in 1877 graduated with the degree of Ph. B. in Biology from the Sheffield Scientific School at Yale. After a year as a student of medicine and a like period as instructor in physiological chemistry at Yale, Mr. Sedgwick went to Johns Hopkins University. Here he was, successively, fellow, instructor, and associate in biology, from 1879 to 1883, receiving the degree of Ph. D. in 1881. In December, 1881, he was married to Mary Katrine Rice, of New Haven, Conn. In 1883, by invitation of Gen. Francis A. Walker, he went to the Massachusetts Institute of Technology as assistant professor of biology, rising to associate professor in 1885, and to the full professorship in 1891, which he has held ever since. In 1902 he was made Director of the Sanitary Research Laboratory and Sewage Experiment Station of the Massachusetts Institute of Technology.

To water-works men and municipal sanitarians Professor Sedgwick made himself widely known during the period from 1888 to 1896, by his services as Biologist of the Massachusetts State Board of Health. In this capacity he took an important part in the studies of water and sewage purification at the Lawrence Experiment Station, collaborating with Hiram F. Mills, Engineer Member of the Board; the late Thomas M. Drown, then Chemist of the Board; and F. P. Stearns, M. Am. Soc. C. E., then Chief Engineer to the Board. It was under the guidance of such men as these, including, of course, Professor Sedgwick, that Messrs. Allen Hazen, George W. Fuller, H. W. Clark, E. O. Jordan, W. R. Copeland, and many other well-known water and sewage engineers, chemists and bacteriologists had their early training and inspiration.

During his connection with the Massachusetts State Board of Health, Professor Sedgwick made a number of notable studies of water- and milk-borne epidemics of typhoid fever, accounts of which may be found in the annual reports of the board. Just before the Columbian Exposition, Professor Sedgwick made, in conjunction with Mr. Allen Hazen, an exhaustive historical and sanitary study of typhoid fever at Chicago, giving comparisons with New York, Boston and other cities (see Engineering News, April 21, 1892). Later, Professor Sedgwick reported on water supply and typhoid fever at Burlington, Vt. (see Journal of the New England Water-Works Association, March, 1896), and at Pittsburg, Pa. (see Report of Pittsburg Filtration Commission, 1899). He has contributed a number of papers to the Journal of the New England Water-Works Association, one of the most valuable being an "end of the century" address, on "The Rise and Progress of Water Supply Sanitation in the Nineteenth Century," read in 1901 before the association which has now chosen him for its President.

A mere enumeration of the most important official positions held by Professor Sedgwick since 1896, many of which he is still filling, indicates his wide range of interests and public and semi-public services: Curator, Lowell Institute, Boston, since 1897; Chairman, Pauper Institutions Trustees, City of Boston, 1897-99, and Acting Institutions Registrar, 1899-1900; Vice-President, Boston Society of Municipal Officers, 1899-1901; Trustee, Simmons College, Boston, since 1899; Chairman, American Society of Bacteriologists,

W. T. Sedgwick

1899, and President, 1900; President, Boston Civil Service Reform Association, 1900, and Massachusetts Civil Service Reform Association, 1901; President, American Society of Naturalists, 1901; President, Board of Directors, Sharon (Mass.) Sanatorium for Consumptives, since 1902; Member, Advisory Board Hygienic Laboratory, Public Health and Marine Hospital Service, since 1902; one of the principal experts, Chicago Drainage Canal Case, 1903-4; Member, Board of Trustees, Faulkner Hospital, Boston, since 1903; Vice-President, and Chairman Section K (Physiology and Experimental Medicine), American Association for the Advancement of Science, 1904-5; Member, School Committee, Brookline, Mass., since 1904.

As a writer or public speaker on his chosen subjects Professor Sedgwick has few equals in clearness, force, grace of expression, and power of holding his readers or hearers. Besides his many official reports, and his addresses and papers before the New England Water-Works Association and other organizations, he is the joint author with the distinguished Professor E. B. Wilson, of Columbia University, of "General Biology" (American Science Series, first edition, 1886); assistant editor of the "Life and Letters of William Barton Rogers," Founder and First President of the Massachusetts Institute of Technology (1896); and author of the "Principles of Sanitary Science and Public Health" (1902). In collaboration with Professor Hough, formerly his Assistant Professor, and now of Simmons College, he has in press an advanced and original text book for high schools and colleges entitled "The Human Mechanism: Its Physiology and Hygiene, and the Sanitation of Its Surroundings."

This sketch would not do full justice to its subject if it failed to mention Professor Sedgwick's notable achievements as a teacher. Of these it is only necessary to say here that to his high capacity for instruction he joins powers of inspiring his pupils with his own zeal for both conscientious routine work and for original research, and that his pupils are eagerly sought to fill positions demanding a combination of high scientific attainments, a willingness to work, and personal integrity; that is, he turns out men as well as scientists.

MOTOR OMNIBUSES AND GARAGE OF THE LONDON POWER OMNIBUS CO.

The London Power Omnibus Co., according to the London "Daily Telegraph" of Dec. 12, 1905, has been running motor omnibuses for about two years. It has recently completed a large new garage, with a capacity of 200 vehicles, and beginning Jan. 1, 1906, its old equipment of 13 single-deck motor buses will be increased at the rate of two double-deck motor buses per week until 75 have been added.

The new garage covers an area of more than 1½ acres. The car-house is 90 × 250 ft., with a roof supported by single span trusses, thus leaving a clear floor space for the storage of 150 vehicles under one cover. Outside the car-house is a large open yard, provided with hydrants and hose for washing the buses. In a second yard there are two underground steel petrol tanks, each with a capacity of 3,600 U. S. gallons. By means of underground pipes and flexible hose, 12 cars may be fed with petrol at once in about five minutes. There is a battery-charging house, 90 ft. long, and a repair shop, 90 ft. long and 60 ft. wide, with single span roof trusses. In this shop are six repair pits. In a storehouse near by all parts of motor buses are kept in stock.

There is a heating and ventilating plant for the car-house, and another for the repair-shop, each provided by the Buffalo Forge Co., of London. Heating alone may be had when ventilation is not required, and portions only of the heating surface may be used, according to temperature needs. To remove or neutralize the petrol fumes when the motor buses are in the car-house, as much as 18,000 cu. ft. of air per min. may be supplied, or enough for two changes of air per hour. Steam for heating the warm air supply is furnished at 15 lbs. pressure. The boiler has unusually large grate and heating surface, and the condensation water is returned to it. The air for heating, or for heating and ventilation when both are supplied, is forced by a large, low speed steel-plate fan over the heating coils and through a pipe system. The air supply may be taken from within the building when heat only is desired. For information regarding the heating and ventilating system we are indebted to the Buffalo Forge Co., of Buffalo, N. Y.

BUILDING OPERATIONS IN BALTIMORE, MD., since the great fire of Feb. 8 and 9, 1904, are of particular interest. During the year of the fire, 1904, the expenditure for new buildings, according to the records of the Building Inspector's Office of Baltimore, aggregated the vast sum of $15,569,450, which broke all previous records of building operations. During 1905, according to the same authority, the aggregate expenditure was $17,198,662. The itemized statement is as follows:

3	market houses	$436,827
3	engine houses	54,327
8	churches	88,800
6	banks	523,000
6	hotels and apartment houses	1,208,600
9	office buildings	3,292,000
275	stores and warehouses	4,672,990
2,030	dwellings	2,790,072
672	additional improvements	627,605
4	hospitals	67,000
1	theater	80,000
16	schools	530,900
	Total	$14,332,220
	To this should be added 20% for under-valuation	2,866,444
	Grand total	$17,198,664

A HOSPITAL CAR FOR THE SOUTHERN PACIFIC RY.

While most large railways have arrangements for hospital accommodation and medical service for their employees, very few have any special arrangements or equipment for dealing with injuries incident to wrecks and train accidents. For such cases, special relief trains are improvised and doctors and nurses (with instruments and other necessaries) are pressed into service. But this often involves considerable delay and a very inadequate supply of materials and facilities for the work of relief, while it makes no provision for the easy and comfortable transportation of injured persons. These difficulties may be largely obviated by the use of special hospital cars, kept fully equipped and ready to be sent out whenever required, being manned by doctors and nurses at the place where the car is stationed or picked up on the way.

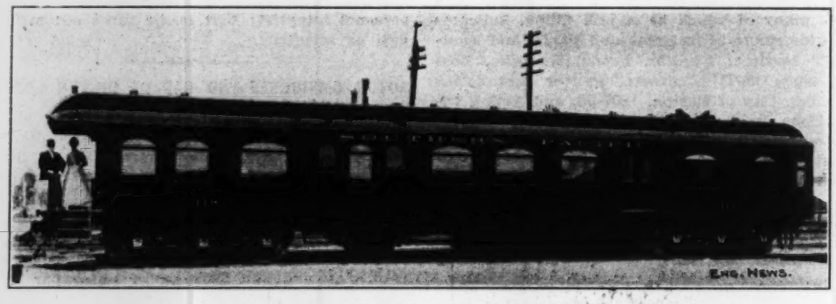


FIG. 1. HOSPITAL CAR FOR THE SOUTHERN PACIFIC RY.

A few railways have hospital cars, but recent inquiry shows that these are very few indeed. It is, therefore, of special interest to note that the Southern Pacific Ry. has recently completed an unusually large and well-equipped hospital car which was built at the company's shops at Sacramento, Cal., under the general direction of Mr. H. J. Small, General Superintendent of Motive Power. It was designed by Dr. F. K. Ainsworth of San Francisco, Cal., Chief Surgeon and Manager of the company's Hospital Department, and we are indebted to him for plans, information, and an opportunity to inspect the car.

As shown in the view in Fig. 1, the hospital car very much resembles an ordinary private car, but has as its special external features the side doors, 4 ft. wide (for passing patients in and out on stretchers), and the long deep locker below the floor, in which the berths are normally stored as described more fully below. The plan, Fig. 2, shows the general arrangement. There are twelve hospital berths and the main hospital portion of the car is divided into two parts; the operating room and the ward. Between them is a semi-partition and they can be shut off from each other by a door so as to make the operating room entirely separate when in use. In this room are the side doors, and ordinarily it is utilized as the dining room. One of the important features of the car is the arrangement of the berths, which are normally stowed beneath the floor, leaving the ward and operating room entirely clear, except for the portable chairs. This construction is on the patents of the American Palace Car Co. (Mr. George W. Denham, President), which has in service a private car built on the same system. Hinged traps in the floor swing up to form the partitions, and the berths are raised and lowered by steel cords wound on drums under the floor and operated by gearing by means of a socket crank-handle fitted to a hole in the floor. When raised to position the berths are supported by locks on the posts, so that their weight is carried directly by the underframing and is not suspended from the roof or sides. With this arrangement, a patient can be laid on the upper berth while it is near the floor, and the berth then smoothly and easily raised to its position. The patient can be placed on the mattress (supported by coil springs), or this can be removed and a stretcher set in place to avoid transferring the patient. The pocket for each pair of berths is large enough to hold two of the upholstered easy chairs with which the car is equipped. These pockets are made dust-tight, but at the same time are ventilated by a current of air. This arrangement of berths was first introduced in the Allen "palace car" built several years ago.

Fig. 3 is a section showing the mechanism for operating the berths. At A is the portable crank handle to be fitted to the heads of shafts B and C, operating the 22-in. drums D and E, which carry the cords for the upper and lower berths, respectively. The shafts B and C have 3⅛-in. sprocket wheels F and G connected by bicycle chains to 6¼-in. similar wheels H and J on the shafts of 3-in. pinions K and L, gearing with 30-in. spur wheels on the drums. The steel cords or cables are of about 500 lbs. capacity each, so that the four cables to each berth can sustain a load of nearly a ton, but as already explained they are under load only when raising or lowering the berths, and do not support the weight when the berths are in position. The cables pass over pulleys M M for the lower berths and N N for the upper berths.

The underframe consists of four center sills and two side sills extending between the end sills, while intermediate sills extend from the berth pockets to the end sills. A rectangular cast steel frame with longitudinal member in the center line of the car takes the place of the usual body bolster, the truck pin passing through a hole in the longitudinal member. Under this frame are two transverse I-beams, and from it extend four 6-in. I-beam platform sills under the main sills. Two trussed transoms are placed beneath the sills, one of these being under the side door openings, and there are four longitudinal truss rods. The upper framing is of the usual passenger car construction, stiffened by inclined brace timbers below the windows; the front end (ahead of the side door) is also trussed by 1-in. diagonal rods extending from above the roof plate to beneath the sills. The end posts are reinforced by steel angles. The sides of the berth pockets are formed by steel channels.

The car has an observation room and a private bedroom (with toilet and shower bath) for the chief surgeon, and ample room for all surgical and medical appliances. The kitchen is unusually large for private car equipment, and there is a Pullman double-berth section (with toilet room) for the porters or servants. A separate toilet room is provided for the patients. At the rear end is a large observation platform, but there are no steps at the forward end, the vestibuled platform having the ice box and refrigerator on one side and porter's toilet room on the other side. This end of the car is fitted with an anti-telescoping vestibule diaphragm. The car has a Frumveller double coil heater and Consolidated steam heating system, and is fitted with Pintsch gas and electric light, the latter generated by apparatus driven from one of the axles. There is a supply of both hot and cold water from overhead tanks. The car is mounted on six-wheel trucks, with special springs, designed to secure great smoothness in running. The car cost about $18,000 and its dimensions are as follows:

Length over end sills	67 ft.	0 ins.
Length over platforms	75 "	11¼ "
Width over side sills	9 "	8 "
Width over eaves	10 "	0¾ "
Height, rail to bottom of sills	3 "	8⅜ "
Height, rail to top of platform	4 "	2⅞ "
Height, rail to top of roof	13 "	9 7/16 "
Wheelbase, trucks (six wheel)	10 "	6 "
Wheelbase, total	61 "	6 "
Trucks, distance c. to c.	51 "	0 "
Weight of trucks	41,000 lbs.	
Weight of car complete	122,550 lbs.	

This hospital car will be stationed at the Oakland terminal (opposite San Francisco) in readiness for use whenever required. It is also intended to have five or six similar but somewhat smaller and less expensive cars built for use at other main terminal points. These will have no observation room, and instead of a kitchen there will be a Pullman buffet cooking equipment. They will all be mounted on six-wheel trucks.

As already noted, very few railways have hospital cars in their equipment, and in fact it is probable that not more than half a dozen such cars are in use. Among these few railways are the Southern Pacific Ry., the Atlantic Coast Line and the Erie Ry. The Chicago & Northwestern Ry. has attached to each wrecking train a car which is normally used as a living and dining car for the crew but which can also be adapted for transporting injured persons, ten transverse beds being made up in the middle portion of the car.

The Delaware, Lackawanna & Western Ry. also has a hospital car which is used principally in cases of accidents at the company's coal mines. It is an ordinary day car, altered to meet the requirements, and having side doors near one end; inside there are six transverse cots, leaving a passage along one side of the car. There are also four ordinary car seats, the cots and seats being covered with enamel cloth. Stretchers and a full equipment of medicines and surgical appliances are carried, and hot and cold water are always available. There is no operating room and only emergency work is attempted, as the car is operated in connection with the Moses Taylor Hospital at Scranton, Pa., and a trip rarely occupies more than an hour.

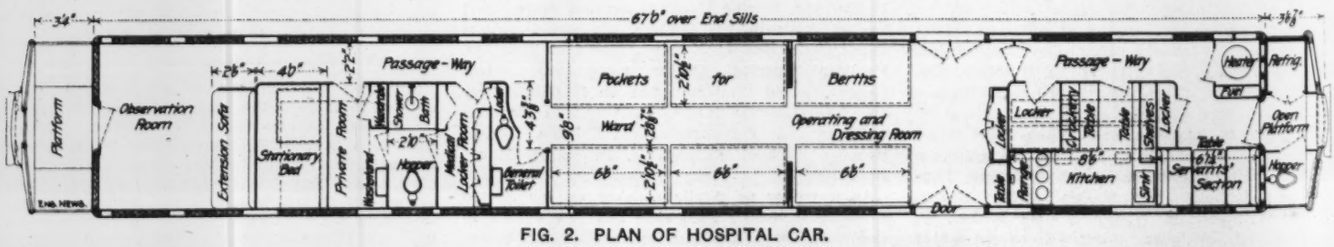


FIG. 2. PLAN OF HOSPITAL CAR.

In regard to the hospital car of the Erie Ry., we take the following particulars from a paper by Dr. Wm. W. Sanford, of New York, which was read before the New York Academy of Medicine some months ago (and published in the "Medical Record"):

Let me briefly describe; (1) a car which is the result of a suggestion of Mr. F. D. Underwood, President of the Erie Ry., and (2) a system of specially constructed and thoroughly equipped hospital cars soon to be inaugurated along the entire length of this railway. When the plan

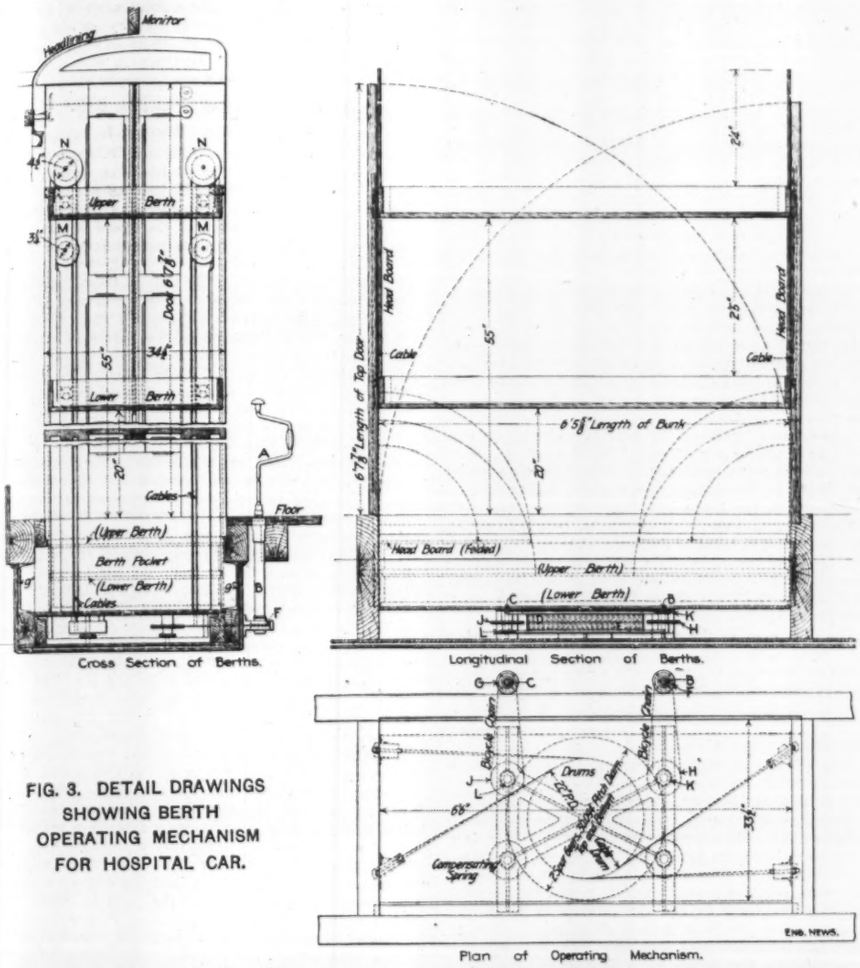


FIG. 3. DETAIL DRAWINGS SHOWING BERTH OPERATING MECHANISM FOR HOSPITAL CAR.

was first proposed, both haste and availability were necessary, and in consequence a combination baggage and smoking car was selected from the regular passenger service. By the removal of the double row of seats and all unnecessary fixtures, sufficient room was secured for the insertion of six ordinary hospital beds supplied with mattresses and rubber sheets. These beds were arranged lengthwise of the car. In the compartment formerly used for baggage, was placed an adjustable operating table, a case of surgical instruments, a small portable sterilizer, splints, stretchers, a cylinder of condensed oxygen, and a few drugs. The heating, lighting, and ventilation remained unchanged. It is readily understood that such an equipment would be of great service, although the crudeness of this car must be apparent, and without several appropriately stationed hospital cars, distant portions of the road might suffer.

The writer has made plans for a new and specially built car which will serve as a type of the several cars to be distributed at convenient distances along this entire road. The interior arrangement will be as plain as possible, and all corners will be rounded. It will be finished in white. The floor will be of white rubber, in block form, capable of adapting itself to the movements of the car while in motion, and easily cleaned.

It will be divided into two compartments, 36 ft. and 14 ft. long, respectively, separated by sliding glass doors of heavy frosted plate, through which a small wheeled stretcher may pass. In the larger compartment, which corresponds to a ward of a hospital, will be inserted eight stationary beds, the frames of which will be of white enameled iron, arranged lengthwise. There will also be two beds suspended in such a manner that all jars of transportation will be eliminated. Each of these beds will be supplied with a comfortable mattress, linen, rubber sheets, and blankets. From a rod, completely encircling each bed, will hang white curtains capable of enclosing such beds when desirable. At the outer end will be a toilet room, the flooring of which will be of white porcelain tiling.

In the smaller compartment, which corresponds to the accident, receiving, and operating room of a hospital, will be an adjustable operating table, a sterilizer for instruments, and specially constructed cases for surgical instruments, for medical agents, and for previously sterilized and encased dressings. At one side will be two porcelain wash basins, with hot and cold water, managed by foot arrangement.

Each car will be cared for by a resident attendant, and inspected by a physician at stated intervals. It is proposed that such cars shall be stationed at accessible points, standing on a special track, so that they may be quickly despatched in charge of a train conductor, collecting en route the company surgeons and trained nurses who have been previously notified by telegraph. By these means we shall have secured three things: (1) Saving of valuable time; (2) A sufficient number of competent physicians and nurses; (3) Equipment at hand.

The large percentage of deaths from injuries received in railway accidents is doubtless due, in part, to the fact that the more seriously injured ones have died from the lack of immediate surgical or medical attention, the result of the absence of facilities at hand and the loss of time in transportation to places appropriate for treatment.

FIG. 4. INTERIOR OF HOSPITAL CAR.
(Berths on the left are in position; those on the right are lowered beneath the floor.)

MODERN PROBLEMS IN GAS ENGINEERING.*

By Fred B. Wheeler.†

A century of effort has been expended on artificial gas manufacture. In hastily surveying the directions in which this effort has been expended, we see that the field has been divided in the various improvements made, between English, Continental, and American engineers. Nearly all changes in the manufacture of coal gas have come from our foreign brothers. In the field of water gas manufacture and purification, America holds the palm. In producer gas work, the honors are evenly divided, and in the development of the by-product coke oven, the Continental engineers have done most of the work.

The gas industry has always been conservative and to a most singular degree, in this country until recently, has been mainly in the hands of technically uneducated men. Here lies opportunity. The chances that lie before a technically educated young gas man to-day are numerous as well as promising. Let me impress upon your minds the fact that the mere manufacture and distribution of artificial gas from gas works (so-called), is soon to be only one section of the gas engineer's profession. The installation of producer-gas works is upon us, the demand is to be tremendous, and some must be prepared for this important work.

The modification and reconstruction of blast furnaces, where the waste gases are used for boiler firing and for power upon an enormous scale, is an integral part of our profession. The great installations of producer gas in steel mills, metal refineries, and electric power houses are bound to grow. The growth of inventiveness is soon to bring into operation a countless host of suction gas producers for small factories, gas engines in ever increasing numbers, and coke oven plants are to be more numerous.

The possibilities are great in this field. The earnings of some gas engineers are very large. I know several whose collective fees and salaries reach $50,000 per year. The supply of technical men does not equal the demand.

I present here some standard gas analyses which you will find very convenient for reference. They are actual analyses upon a big scale and made most carefully.

*From a lecture delivered before the engineering students of the University of Wisconsin and published in "The Wisconsin Engineer" for December.
†The Semet-Solvay Co., Syracuse, N. Y.

Table of Standard Gases.

Composition.	Coal Gas, English.	Coal Gas, American.	Coal Gas, German.	Solvay. Coke oven 8 c. p.	Solvay. Coke oven 16 c. p.	Mond Producer.	Morgan Producer Bituminous.	Wilson Producer.	Taylor Producer.	Carbureted Water Gas.	Blue Gas.	Carbureted Water Gas.	Carbureted Water Gas.	Blast Furnace Gas.
O_2	80	1.07	3.01	.83	1.61	14.6	4.0	3.4	4.5	4.6	3.5	.14	3.8	11.5
$CnHn$	1.06	1.80	1.83	.45	1.04							1.53		
C_2H_4	2.47	4.11	3.76	2.70	4.89			.8		21.2		11.29	14.6	
O_2	.49	.12	.65	1.10	.57	.50	.60		.6	1.0		.06		
CO	4.23	5.90	8.88	3.00	3.05	10.3	25.0	25.1	25.5	14.8	43.4	28.26	28.0	27.5
H_2	52.22	45.52	46.20	52.10	39.80	28.5	19.4	9.2	12.0	18.4	51.8	37.20	35.6	5.0
CH_4	34.78	37.91	34.92	36.60	39.21	5.3	9.6	3.1	1.9	30.7		18.88	17.6	
N	4.23	3.54	2.15	2.70	9.83	55.8	41.4	58.2	56.4	9.3	1.3	2.64	1.0	60.0
BTU	635.00	730.0	642.0	648.0	688.7	160.5	223.0	155.0	132.0			650 } 591 }	764	112-128
Sp. gr	.46	.498	.478	.40	.47									
c. p.	16.00	18.00	16.00	8.06	15.87					26.0	0.	22.06	26.0	

Gross B. T. U. per cu. ft. Conversion Table.
0°C. = 32° F. and 760 mm. pressure.

H_2	343
CO	341
CH_4	1065
C_2H_4	1673
C_6H_6	4011

For 60° F and 30 ins. barometer multiply by $\frac{1}{491.4} =$ .002035 for each degree rise.

The table represents English, American and German coal gases, Solvay coke-oven gas from Milwaukee and Detroit, Mond, Morgan, Wilson and Taylor producer gases, blue water-gas, three different grades of carbureted water-gas, also blast furnace gas. The tables show the B. T. U. per cu. ft., also the candle power.*

I show a table of gross B. T. U. per cu. ft. for 0°C. and 760 mm. The volume per cents of the chemical components, multiplied by the factor, will give, when all are added together, the gross B. T. U. To change the volumes to 60° F. multiply by the factor shown per degree.

The magnitudes of the volumes produced in the operation of some modern gas works will, I hope, rivet your attention.

At a certain works it was proposed to measure daily, at the point D, 90,000,000 cu. ft. of gas at the standard temperature 60° F = 15.5° C.

A——B——C——D

This gas produced at A would have actually at the B point where it enters the machinery, the temperature 212° F. = 100° C. the temperature of boiling water. On account of the peculiar properties of water vapor tension, the volume of this gas, if saturated, would be the enormous quantity of 3,375,000,000 cu. ft. This mass of gas would have to be cooled down to the required volume, 90,000,000 cu. ft. at D. In other words, it would be reduced in bulk 37½ times under this condition. Every piece of machinery between B and D under this condition would have to be designed to handle this mass scientifically as well as practically. About 640,000,000 gallons of water would be required and this would need a centrifugal pump station of 30,000,000 gallons per hour capacity.

In cooling down this gas we run against the vapor tension of ammonia at the Point C, and extract there the ammonia liquor. The water thus produced there daily is the equivalent of 90 tank cars of 6,000 gallons each and it has to be distilled daily to a reduced bulk of three tanks; 3,000,000 cu. ft. of gas per day, and 30 to 36 tank cars of liquor are handled daily now.

At the point B, a mass of gas whirls through the machinery at the rate of 2,343,000 cu. ft. per minute, or as much as would supply the capital city of Wisconsin one week.

I have said nothing about the acres of coal fed into the furnaces, and the rivers of coke poured out of the furnace doors to round out this operation. Nor have I said anything about the thousands of gallons of coal tar and benzol that have to be cared for at this plant.

A large quantity of this gas is washed in a veritable river of hydrochloric acid, the strength and temperature of which has to be carefully watched and allowed for. A part of the gas is cleansed of sulphur impurities in beds of oxide of iron, and a part is washed in heavy oil to absorb benzol, the gas being required for different purposes. The capital cost of this plant runs into the millions.

At the point B to C is a place where it is quite possible to make large improvements in the first cost of installation, and also in the operation cost, by a change to an entirely new principle, the principle of mechanical condensation by rotary centrifugals.

This mechanical condensation is being accomplished in several different ways in Europe, and American engineers are now thinking it over. I believe two or three experimental trials are being made here now. Personally I have given a great deal of study to the idea of the extraction of tarry and aqueous matters by rapid rotation, especially in helicoidal screws.

Gas engineers have now before them several important general engineering problems. They are:

1. Vertical retort distillation of coal.
2. Modified coke ovens inside of retort houses.
3. The high pressure distribution of gas.
4. Gases for power.
5. Producer gas development.
6. Chemical treatment of residuals.
7. Naphthalene recovery.
8. Benzol enrichment of lean coal gases.
9. Proper condensation.
10. The development of large unit gas engines for central station work.

(*For additional data see "Journal of Society of Chemical Industry," June, 1905, pp. 592-604.)

As an example of evolutionary growth in one item of gas works manufacture—the retort furnace—I will run over the line of development that has led up to the vertical retort.

The retorting of coal began with a gradual succession of 1, 2, 3, 4, 5, and 6 retorts in a furnace, called a bench. The retorts were first of iron, then of clay, heated by an open fire. Benches of 4's and 6's of this type are to-day in extensive use. They consume from 20% to 33% of the coke produced. These furnaces receive the air in the combustion chamber but slightly heated.

Recuperative and regenerative furnaces were next made and the number of retorts increased from 6 to 8, 9 and 10 per bench. The air supplied to the fire in the combustion chamber was highly heated by the waste heat products of combustion before passing to the chimney. In the German Munich patent benches with the fire outside the bench in a generator, long runs of as low as 16% of coke made, consumed as fuel, have been made; the yields per bench of these standard 6's running to 72,000 cu. ft. per bench per day.

The next stage was inclined retorts, elaborate affairs, the retorts being tilted at an angle of inclination proper for hot coke to slide down and out, when suitably burned. A good installation is to be seen at Louisville, Ky., also in Brooklyn. These produce 100,000 cu. ft. or more to the bench.

The coke oven in the shape known as the by-product coke oven came in ahead of the inclines. It is a successful producer of gas as well as coke on a large scale. A coke oven of this type is now built 35 × 8 × 16 ft., holding 7¼ tons of coal, which is burned off in 18 to 20 hours, producing 9,000 ft. of gas per ton from coals only partially gas coals.

The next scheme was to house these ovens on a smaller scale in retort houses. Three installations of these are now on trial in Germany. Simultaneously with this development was revived a very old idea of having the retorts vertical. Six experimental installations have been tried out successively at Dessau. At present 20 verticals there produce an average of 14,500 cu. ft. of 13-c. p. gas each, or 193,333 cu. ft. per man, it only requiring 1½ men practically to run the carbonizing plant.

This system produces better coke, more ammonia, more and better tar, with less labor than does any other known form. The improvement is bound to be a success and will surely spread in use. These retorts are built in blocks of 10 with one generator which only has to be fed with coke once in 24 hours and clinkered once in 48 hours. The fuel consumption is 20% of the coke produced. A plant is now also being built in Berlin. The remarkable fact is shown that the retort temperature is 1,400° C., yet the waste gases escape at only 310° C.

The plan is also used of putting two retorts into one, by setting the retorts end to end, the benches being built back to back, knocking out the back walls. Thus two 10-ft. retorts are made into a 20 or 22-ft. retort. They cease to be charged by hand. Coal is fed in and coke pushed out by machinery. A fine example of such retorts is to be seen at the Milwaukee gas works.

The question of long life of retorts and low repairs is a most vital one. Coking time is an important factor. English practice runs from 5 to 8 hours. American practice runs from 4 to 5½ hours. Coke ovens practice runs from 18 to 24 hours. Verticals practice runs from 8 to 10 hours.

Outside of the large cities like New York, Philadelphia, St. Louis, Boston, Detroit, Milwaukee, Cincinnati and Louisville, Ky., there are few noteworthy gas engineering achievements in this country. It is to Europe we must turn for examples of engineering on a great scale in gas works, especially in Great Britain and Germany.

Dessau, Germany, has a noteworthy record. Here was installed the first retort setting fired with producer gas 30 years ago. Here was installed the first electric station run by gas engines 20 years ago. Here was installed the first tramway with gas locomotives 10 years ago, and now there is being installed the first successful vertical retorts.

Magdeburg, Germany, first made a very low candle power gas of high heat units, and distributed it to the whole city, using Welsbach mantles—abolishing completely open flame burners.

Vienna and Berlin have taught the world how to construct inclines. Brussels has shown us marvels in residual recovery, and in Great Britain we have a blaze of gigantic installations of the greatest feats of engineering, Sheffield leading the world with 26 ct. gas.

The high pressure distribution of gas through large cities, and from centers of population to outlying towns, which would otherwise have either to go without gas, or suffer a higher price by the operation of a separate works, occupies a commanding position in the mind of all gas engineers, as well as the thoughtful attention of investing capitalists.

METHODS OF CHARGING FOR GAS.*

By Alfred E. Forstall.†

As far as the writer's knowledge goes, this paper is the fourth one on the subject of "Methods of Charging for Gas" that has been read before the Association. The first, read in 1891‡, and the second, read in 1898§, dealt principally with the question of the equity of the common practice of charging for gas a fixed price per 1,000 cu. ft., which was the same, either for all the consumers supplied by a company or for all of those in certain classes, without any regard to the differences in the cost of supplying different consumers arising from the different conditions under which the supply is taken in each case.

The author of the first of these papers, Mr. Walton Clark, submitted that it was inequitable to "collect upon the investment necessary to the service of one customer an interest greater or less than is paid by any other customer upon the investment made in his behalf," as was necessarily done when the charge for gas was simply a uniform price per 1,000 cu. ft., and that the equitable way of charging for the service furnished by the gas company was "to charge for each 1,000 cu. ft. of gas an amount covering its proportion of the items of expense and interest common to the performance of the total service, adding to each bill so made the items peculiar to the individual service." The charge per 1,000 cu. ft. should include the cost of supplying up to the inlet of the service pipe, including the amount per 1,000 cu. ft. necessary for the payment of interest and dividends, and the individual items should be made up of the average cost of keeping the accounts, collecting the bills and attending to complaints, plus the interest and maintenance charges for the meter and service pipe employed for the particular consumer under consideration.

In the second paper the present writer, who was forcibly impressed, upon taking charge of the commercial after a service of twelve years on the engineering side of the gas business, with the number of consumers who, instead of bringing in a profit, were actually a source of loss when the expense of taking care of their accounts and the interest on the cost of and the expense of maintaining their services and meters were taken into consideration, showed the effect that the system of charging advocated by Mr. Clark would have if applied to the gas company which he was then managing. For that particular case it was shown that the total cost per consumer of the maintenance of service, interest, depreciation and repairs on meters, and labor keeping the consumers' ledgers, making out and distributing bills, collecting the money for gas sales and attending to complaints was, for an average length of service, but for different sizes of meters:

3-lt. meter, $2.25 per year. 20-lt. meter, $3.30 per year.
5-lt. meter, 2.50 per year. 30-lt. meter, 3.80 per year.
10-lt. meter, 2.90 per year. 45-lt. meter, 4.90 per year.
60-lt. meter, $6.20 per year.

Therefore, before the company came out even on the business of any consumer using a 5-light meter it was necessary that he should consume in a year an amount of gas that would bring in a profit equal to $2.50. If fixed charges on the amounts named above had been made and the price charged per 1,000 cu. ft. of gas reduced to such an extent that the gross revenue from fixed charges and gas sold remained the same as the gross receipts from gas sales at the higher price per 1,000 cu. ft. without fixed charges, the consumptions at which consumers would pay exactly the same amount in each case were:

For a consumer using a 3-light meter 19,000 cu. ft.
For a consumer using a 5-light meter 21,000 cu. ft.
For a consumer using a 10-light meter 24,000 cu. ft.
For a consumer using a 20-light meter 28,000 cu. ft.
For a consumer using a 30-light meter 32,000 cu. ft.
For a consumer using a 45-light meter 41,000 cu. ft.
For a consumer using a 60-light meter 52,000 cu. ft.

Under the existing conditions the 63% of the consumers who used smaller amounts than these were not paying their proper share of the profit earned by the company, while the 37% using larger amounts were paying more than their share.

These papers received very little attention when they were read, the authors being told that they were probably right as to the equity of the proposed method of charging but that it was impracticable and never could be put into operation.

The third paper was read by Mr. F. W. Frueauff at the last [1904] meeting of the association. It approached

*A paper read before the Thirty-third Annual Meeting of the American Gas Light Association, at Milwaukee, October, 1905.

†Consulting Gas Engineer, 58 William St., New York City.

‡"Meter Rents; a Question of Equity and Policy": Proceedings of the American Gas Light Association, Vol. IX., page 517.

§"Can We Make All Our Business Pay?": Ibid. Vol. XV., page xxxv.

the method of charging for gas along the line that had been followed by Mr. H. L. Doherty in working out the system of charging for electricity which is named after him. In this system a prominent place is given to the cost incurred by the electric company to enable it to take care of the maximum demand of the consumer, and a special charge is made to cover this cost under the name of a "maximum demand charge." In applying the method to the gas business this feature is retained and it is proposed to make a maximum demand charge in addition to the consumer's charge and to that per 1,000 cu. ft. of gas sold. It is stated that an analysis made of the accounts of a gas company

brought out the startling fact that 19% of all consumers did not pay their output and consumers costs, that 34% did not pay their manufacturing, meter and demand costs, and that only 34% paid all the costs they occasioned, or that this 34% paid enough in excess of a reasonable amount to enable the company to make good its loss on the unprofitable consumers. This leads to but one conclusion, that they are doing business with a great many consumers that are losing them money each month, and that they are selling them a very small quantity of gas, and from the other end of the table they found that from the comparatively few consumers who were using a large percentage of gas they were making a very large profit after paying all costs.

It will be noted that the percentage of consumers carrying more than their share of the burden in this case does not differ materially from the corresponding percentage as given in the second paper. To remedy these conditions it was proposed to put into effect

an optional system of charging whereby any of their consumers can buy gas by paying $12 per consumer per year, plus $15 per 100 ft. of maximum demand, plus 60 cts. per 1,000 cu. ft. for gas.

It does not seem to be necessary to repeat the arguments advanced in these papers, and never refuted in the discussions upon them, in favor of the system of charging outlined. The system advocated in the last paper read is rather more elaborate than that advocated in the other two papers, but there is good reason for making charges of the character described in that paper. No information is given, however, as to the manner in which the amount of the maximum demand charge, which is not nearly as important in connection with the gas business as it is with the electric business, and that of the consumer's charge, which are named in the paper, are determined to be the proper and equitable ones for this particular case, and, since maximum demand and consumers' charges that are not based upon actual costs are just as inequitable, and therefore in the long run just as bad policy, as a simple uniform charge per 1,000 cu. ft., and as these charges seem to me to be entirely out of proportion to the cost of the service, I propose to take up the question of the items that should be included in each charge and of the approximate value of these items. In doing this the classification of the standard system of accounts adopted by the association will be followed.

The items of cost that are imposed upon a gas company by the fact that the demand of each consumer for gas is not uniform, but varies from hour to hour and from day to day, are those involved by the extra investment in plant required to supply the maximum demand over and above the investment that would provide all the plant called for by the average demand. No labor costs need be taken into consideration since, although the intermittent working of a part of the apparatus, which is made necessary by the fluctuations in demand, does involve a slight extra cost for labor, this is so small in proportion to the other items as to be fairly negligible. The maximum demand charge is therefore made up of:

Interest and depreciation upon the cost of the portion of the manufacturing plant required to take care of the excess of the maximum make over the average make.
The extra cost of maintenance involved by the use of this portion of the manufacturing plant.
Interest and depreciation on the extra cost of the street mains actually required on account of the size of the maximum demand, over the cost of the mains that would be required to take care of the average sendout.
The extra cost of maintenance of street mains involved by their larger size, owing to the maximum demand.
Interest and depreciation on the extra cost of service pipe actually required on account of maximum demand over the cost of the pipe that would be required for the average consumption.
The extra cost of maintenance of the service pipe involved by its larger size.
Interest and depreciation on the extra cost of the meter actually required on account of the maximum demand over the cost of that which would be sufficient to supply the average demand.
The extra cost of maintenance of meters involved by this extra size.

Taking up these items in the order in which they are given, which is not only their order in the sequence in importance, the first to be considered is the interest of manufacturing and distributing operations, but is also, with the exception of the maintenance items, their order and depreciation on the cost of the excess plant made necessary by the maximum demand. It would seem that to make an equitable charge on account of this item the conditions must be taken as they actually exist and not as they would exist if the gas company were supplying each of its consumers singly. Thus all that has to be provided for is the maximum demand resulting as an average of the maximum demand of all the consumers combined, and therefore this item has no relation to the maximum demand of any individual consumer and must be averaged among them all. To obtain its value accurately it is, of course, necessary to consider all the conditions of each individual case, but for the purpose of getting an approximate idea of what it should be, it can be worked out assuming that the maximum day's make is 1/200 of the annual sales and that the average sales per consumer will be 25,000 cu. ft. per year. If the average sales per consumer are larger than this it is practically certain that the maximum day's make will be a smaller proportion of the annual make and the increase in one direction is offset by the decrease in the other, so that the figures obtained on this basis will be fairly approximate.

The extra plant required by the excess of the maximum demand over the average demand will include the entire holder capacity and 165/365, or 45% of the total manufacturing plant. Assuming average conditions as to the holder capacity provided and as to the cost of holders and manufacturing apparatus, the excess investment at the works, made necessary by the excess of the maximum demand over the average demand, will be $25 per consumer. Taking interest and depreciation on this investment at 10% the annual charge per consumer will be $2.50 per year.

By a calculation, the details of which it is not necessary to give, it is found that under the conditions named the extra cost of maintenance of the manufacturing apparatus and holders involved by the intermittent use of the former will amount to 30 cts. per year per consumer.

As far as the street mains are concerned few, if any, gas companies have a maximum rate of sendout per hour which is larger than 1/1600 of their total yearly sales, and as the average sendout per hour is 1/8760 of the yearly sales the maximum demand requires that the street mains have a carrying capacity of $\frac{8,760}{1,600} = 5.5$ times that which would be required if the demand were perfectly uniform throughout the whole year. In the average street main system the average size of main works out a little under 6 ins. in diameter, both as to size and as to cost of laying. If the sendout were absolutely uniform it would only be necessary to have a street main system equal on the average to pipe of 3 ins. in diameter, since a 6-in. pipe has a carrying capacity practically 5.5 times that of a 3-in. pipe. The difference in cost between a 6-in. main and a 3-in. main would not vary very much from 25 cts. per lin. ft. in any locality. It is not out of the way to take an average of 100 consumers per mile, or one consumer for every 53 ft. of main. The excess investment in street mains per consumer caused by the maximum demand will therefore be 53×25 cts. = $13.25, and interest and depreciation on this at 10% will amount to $1.33 per year. This is also an average charge resulting from the combined demands of all the consumers and is therefore to be averaged among them and not to be calculated on the maximum demand of the individual consumer.

To a certain extent the maximum demand of each consumer will influence the size of pipe laid in his immediate vicinity, but this is, comparatively, such a small matter that it would not seriously affect the amount of the figure derived above.

It is rather difficult to figure the extra cost of maintenance involved by a street main system of an average of 6-in. pipe instead of one of an average of 3-in. pipe. Under ordinary conditions the cost of street main maintenance depends largely upon circumstances the effect of which is not increased by increase in the size of the pipe, and in many systems the greater part of the cost of such maintenance is due to breaks in the pipes smaller than 4 ins. in diameter, and on the whole the cost of maintaining the 3-in. system would probably be fully as great as that of maintaining the 6-in. system, so that this item will not influence the total.

In determining the extra cost of the service pipe involved by the excess of the maximum demand over the average demand it must be remembered that other considerations besides the amount of gas to be carried have a great influence upon the size of pipe that is to be laid in any given case. There is no need to go into these considerations in detail, but the practice in laying service pipes to street lamps, which furnish a case of uniform consumption without any expectation of future increase, may be taken as sufficient proof that under no conditions would a service be laid of pipe smaller than ¾-in. in diameter. Some companies, in fact, lay no lamp post service smaller than 1 in. The excess investment occasioned by the maximum demand of the consumer may therefore be taken as being only the difference in cost between the size of the service actually required and the minimum size, ¾-in., that would be laid in any case. This extra investment has, of course, to be figured for the individual consumer, but for the purpose of this paper a consumer with a maximum demand of 80 cu. ft. per hour will be taken. Such a consumer could be supplied with a 1-in. service, but most gas companies would lay a 1¼-in. service, and the excess investment occasioned by the maximum demand may be taken as the difference in cost between a 1¼-in. and ¾-in. service. This difference in cost will be practically the difference in the cost of the pipe and fittings used, since the laying of a ¾-in. service would call for as much labor as the laying of a 1¼-in. service. Taking the low discount of 60% from list prices the difference in cost between 1¼-in. and ¾-in. pipe will be 3.75 cts. per ft. With an average length of service of 70 ft., this difference in cost of pipe combined with the difference in cost of the fittings would make the larger service cost, say, $2.80 more than the smaller service. If a stop-cock is provided at the curb 45 cts. must be added for the difference in cost between a 1¼-in. and a ¾-in. cock, making the total excess of the larger service $3.25. Interest and depreciation on this at 10% would be 33 cts. per year.

The difference in cost of maintenance between one service and the other is practically negligible, as in the case of the street mains.

In the case of meters there must be taken into consideration the question of whether a meter smaller than the present 3-light size would be any cheaper than one of that size, and the meter manufacturers will probably agree that practically nothing could be saved in cost by going below the present 3-light size. The extra investment in consumers' meters involved by the maximum demand of the consumer is therefore only the excess cost of the meter actually set over that of a 3-light meter. For a maximum demand of 80 cu. ft. per hour a 5-light meter is ample. This will cost, unset, $1.40 more than the 3-light, and with a liberal allowance for the extra cost of connections, and setting, the extra investment occasioned by the maximum demand would not be above $2 for this class of consumer. Taking interest and depreciation at 15% in this case, on account of the life of the meter being shorter than that of the manufacturing apparatus, street mains and services, the maximum demand charge on account of meters for the case named would be 30 cts. per year.

While it is rather difficult to name exact figures for the extra cost of maintenance involved by the necessity of using a 5-light instead of a 3-light meter, 10 cts. per meter per year would seem to be a very liberal allowance.

Summing up the various charges as determined above, we have for the total maximum demand charge per year for a consumer with a demand of 80 cu. ft. per hour:

Manufacturing plant, including holders	$2.50
Maintenance on above	.30
Street mains	1.33
Services	.33
Consumers' meters	.30
Maintenance of consumers' meters	.10
	$4.86

An effort has been made to have these figures err on the high side instead of on the low side, and in many cases it will probably be found that $4.75 would be an ample maximum demand charge for a maximum demand of 80 cu. ft. per hour. If this charge varied in exact proportion with the variation in the maximum demand, this would make a charge of about $6 for a maximum demand of 100 cu. ft. per hour.

The items of cost to be included in a consumers' charge would be:

Complaint expense.
Gratuitous work.
Repairs to services.
Repairs to meters, less the amount of such repairs taken care of in the maximum demand charge.
Setting and removing meters.
Expense collection.
Cost of consumers' ledgers.
Carfare for meter readers.
Gas bills.
Expense of reading and indexing meters.
Salaries of bookkeepers on consumers' ledgers, of bill clerks and of cashiers.
Interest and depreciation on the cost of a service of the size required to furnish gas at the average rate.
Interest and depreciation on the cost of a meter of the size required to furnish gas at the average rate.

The items made up of the cost of labor and materials will vary with each company and will have to be determined by each company for itself, but it is probably safe to say that they will not exceed, in any well managed, even though comparatively small, company, $2.50 to $3 per consumer, where, as would be the case with this system of charging, it would only be necessary to set one meter per consumer. The higher figure may be taken for the purpose of this paper.

It was determined in dealing with the maximum demand charge that a ¾-in. service may be taken as the size required to supply the average demand of the ordinary consumer and the cost of such a service of an average length of 70 ft. should not be more than $8. Interest and depreciation at 10% will give a charge for this item of 80 cts. per year.

It was also determined that the cost of the meter required for the average demand of the ordinary consumer might be taken as equal to that of a 3-light meter. The interest and depreciation on such a meter may be taken as $1 per year. The total consumer's charge would therefore be:

Expense for labor and material	$3.00
Interest and depreciation on cost of the service	.80
Interest and depreciation on cost of the meter	1.00
	$4.80

The charge per 1,000 cu. ft. of gas used, to be made in connection with these maximum demand and consum-

ers' charges, would be such as to cover all the operating expenses not specifically assigned to one or the other of the latter charges and the profit which the company is entitled to make. This charge per 1,000 cu. ft. must be determined separately for each company and cannot be made the subject of a general discussion.

It may be argued that the demand and consumers' charges should be made sufficiently high to cover a portion of the profit, but such a course would not conform to the requirement that no greater profit be made off of one consumer than is made off of another when the same service is rendered to each. The maximum demand and consumer's charges make each consumer pay the cost of everything that is furnished him except that of the gas which he uses, and therefore the unit of service which is common to all cases after these charges have been made is the delivery of 1,000 cu. ft. of gas, and all the profit must be included in the cost of this unit if it is to bear equally upon all consumers.

This system of charging has been applied, as far as the consumer's charge is concerned, in the case of one small gas company, and each of its consumers pays 25 cts. per month as a fixed charge irrespective of the amount of gas consumed, the bills rendered carrying the two items of "Gas Consumed" and "Fixed Charge." Many of the consumers use only small amounts of gas, and without this fixed charge would be a source of loss to the company, but with it they pay their own way. By the action of this charge the price paid for gas is automatically reduced as the consumption increases, the consumer of less than 1,000 cu. ft. per year paying at the rate of about $5 per 1,000 cu. ft., while the consumer who uses the largest amount of gas obtains it at a total price of $1.75 per 1,000 cu. ft. The conditions of manufacture and distribution are such that the equitable maximum demand charge would be very small and it was not considered advisable to make it as a separate item. The consumer's charge is probably too small for present conditions, but the services are short and the district very compact, and as the business is developed this charge should prove adequate. If it does not, a change can be made at the proper time, accompanied by such a reduction in the price per 1,000 cu. ft. of gas that the total charge to consumers of small amounts will remain practically as it is at present, while the consumers of large amounts will obtain a substantial reduction. After an experience of eighteen months of this method of charging, the managers of the company are entirely satisfied that both the consumers and the company are better off than would be the case were the charge of gas simply a uniform price per 1,000 cu. ft.

Believing firmly in the justice, and therefore the policy, of a method of charging for gas that will make each consumer pay his share, and no more than his share, of the expenses and the profit of the gas company serving him, I hope that this paper will aid the doing away with the present method of charging, under which from 20 to 25% of the consumers are served at an actual loss to the company and an additional 35 to 40% do not return their fair share of the profit, while the remainder return an excessive profit.

THE DESIGN OF HIGH ABUTMENTS.

By Wm. M. Torrance,* M. W. S. E.

The Illinois Central R. R. bridge over the Ohio River at Cairo, Ill., was built in 1887-1889 by the Union Bridge Co., with Anderson & Barr subcontractors on foundations and L. M. Foss subcontractor on masonry, the work being designed and built under direction and management of the late Geo. S. Morison, M. Am. Soc. C. E., chief engineer, with Mr. E. L. Corthell, M. Am. Soc. C. E., associate chief engineer, and Mr. Alfred Noble, M. Am. Soc. C. E., resident engineer.

The total length of the bridge proper from center to center of end piers is 4,644 ft., with a steel approach on the Illinois side of 17 deck Pratt truss spans of 150 ft. each and one deck Pratt truss span of 106.25 ft., and on the Kentucky side of 21 deck Pratt truss spans of 150 ft. each and one deck Pratt truss span of 106.25 ft., in each case the 106.25 ft. span being at the extreme end of the metal work. The total length of the metal work is 10,560 ft., which made the structure, when built, the longest metallic structure in the world.

The bridge was built in conformity with the Ohio River Bridge law, which specifies that "the axis of the bridge shall be at right angles to the current at all stages, and all of the spans shall be through spans." It also specifies that every such bridge shall have at least one channel span of 500 ft. clear opening measured on low water line. It also specifies that where pivot draw-bridges are not provided, such bridges "may be built as continuous bridges with a clear height of 53 ft. above local highest water, measured at the lowest part of the channel span."

The Cairo Bridge was built with two through spans of "500 ft. clear opening," being 518.5 ft. c. to c. of end pins, seven through spans 400 ft. c. to c. of end pins, and three deck spans 249 ft. c. to c. of end pins, the option being taken of omitting draw spans by constructing the channel spans with 53 ft. of clear head-room above extreme high water (53.22 ft. as actually built), thus making it a high level bridge, with necessarily long approaches. The bridge as built was a single track bridge from end to end, including the pile and timber trestles built by the railroad company at each end of the steel work, which amounted to about 5,000 lin. ft. at each end, thus making a total length of inclined approaches and level main spans of nearly four miles.

Almost immediately after the bridge was built, the railroad company began the filling of the timber approaches, finishing the work within a few months. A few years later these approaches to the steelwork were double-tracked by widening the embankments.

The Mobile & Ohio R. R. consists of two geographical divisions, the one being from St. Louis to Cairo, Ill., and the other from East Cairo, Ky., to Mobile, Ala. This railroad company, since the completion of this bridge, has been using it jointly with the Illinois Central in its through traffic, paying the Illinois Central for this use. The writer has heard it stated that this revenue to the I. C. R. R. from the M. & O. R. R. has been sufficient to pay the interest on the total cost of the bridge. At any rate, the single track bridge is a "congested traffic" spot. The main line of the Illinois Central is double-tracked each way; there is also a new single track line of the I. C. R. R. of quite heavy traffic from the Kentucky end of the bridge to Paducah, Ky., and finally there are the heavy traffic single track lines of the Mobile & Ohio leading from each end. There is really business enough across the Ohio River on this bridge for three tracks instead of for one, especially on account of the heavy grades on and the great length of the approaches.

The management of the Illinois Central R. R. have long contemplated the double-tracking of this bridge as a necessity—many officials acknowledging that it was an error not to build it with double track in the first place, or at least to leave it so that it could easily be double tracked—and early in 1903 plans were made for the beginning of this work, namely, to fill with double track embankment the whole of the Illinois approach and a part of the Kentucky approach, using the steel spans thus released to double track the remaining spans of the Kentucky approach, using six trusses for the double track where two had been used for single track.

These plans contemplated extensive yard track changes in the tracks underneath and alongside the Illinois approach, and a long concrete arch to carry Sycamore St., Cairo, through the embankment to be made. They also contemplated the construction of a high abutment at each end of these embankments. The plans also contemplated the future double-tracking of the river spans, either by taking off the top of the piers and corbeling them out wide enough for double-track bridge seats, or by their reconstruction from much lower down. The center line of the present track was to be the center line of the double-track bridge.

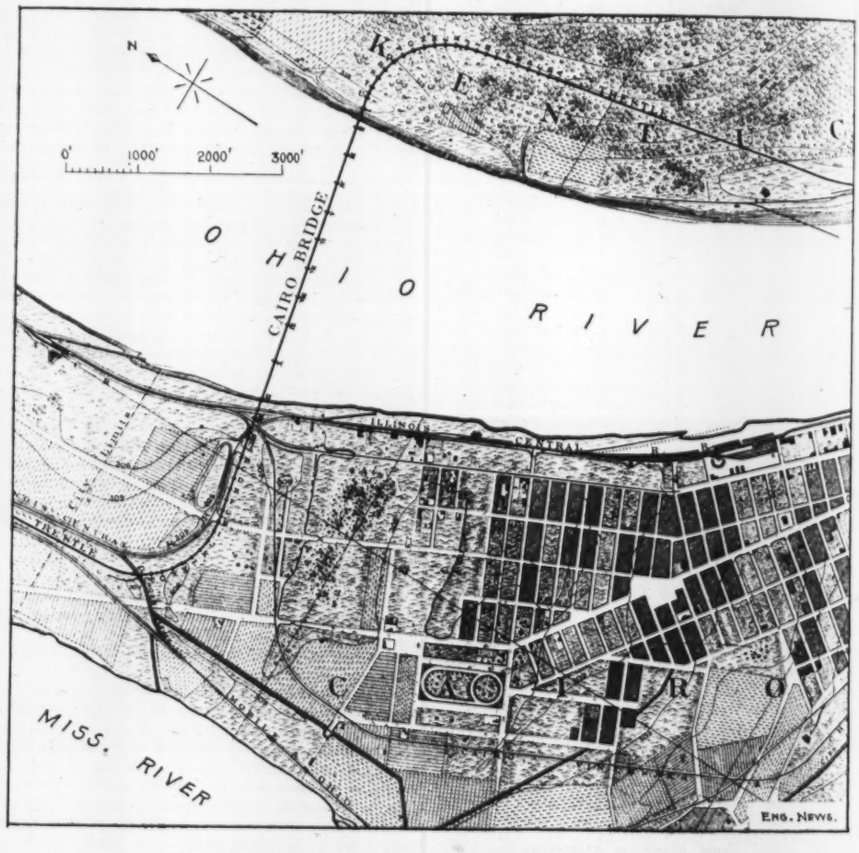


FIG. 1A. PLAN OF CAIRO BRIDGE AND APPROACHES.

Contracts were made with the Bates & Rogers Construction Co. for the concrete masonry work according to these plans, and work was about to begin in May, 1903. The writer was engaged at the time as resident engineer on another improvement on the Illinois Central, but for a time in May and June, 1903, he acted as resident engineer in charge of this Cairo improvement in laying out the start of the work. The plans for the two abutments mentioned, as approved, and on which the contracts had been made, were for wing wall abutments, as shown in Figs. 2 and 9. The writer suggested to the assistant engineer of bridges, Mr. F. H. Bainbridge,* that it might be cheaper and better to construct T- or U-abutments, perhaps of reinforced concrete arches or other hollow construction, and, perhaps, to allow earth to spill around in front of the abutments, rip-rapping the

*Construction Superintendent, with Hudson Companies, Foot of 15th St., Jersey City, N. J.

*Now Principal Assistant Engineer, Chicago & Northwestern Ry., Chicago, Ill.

surface of this fill at the abutments if necessary.

In the accompanying drawings are shown results of an investigation made by Mr. Bainbridge and the writer on account of this suggestion. The existing Pier XIII. (Fig. 1) was designed to remain the west support for the 249-ft. deck span between Piers XII. and XIII., its top being already wide enough for the support of a double-track deck span, to be later substituted for the present single-track structure, and the abutment at the end of the Illinois approach embankment was, in all these designs, designed to incorporate same as a part of its structure. None of the estimates include the cost of this pier, which was built with the rest of the Cairo Bridge in 1887-1889.

Fig. 2 shows Proposition I., the plan for this Illinois approach abutment as approved, and as contracted to be built, previous to this investigation. This design, according to standard ideas of wing wall abutments, and, as shown, is very wide in the base, on account of the great height, as short, in fact, as possible and keep the earth from the steel of the deck span. This proposition would require 13,500 cu. yds. more filling than Propositions I. or II. on account of the spilling around in front from the lack of wing walls, but the total cost is much less than either, being estimated at $27,409.75. On account of the simpler form work required for this design, and the greater proportion of it which could be of a less expensive mixture of concrete, the concrete is estimated at $5.75 per cu. yd. instead of the $6 as in the estimates for Propositions I. and II. The unit pile loading in this case is also 20 tons.

Figs. 5 and 6 show two plans for this abutment, both being rather massive hollow reinforced concrete construction. These are in the nature of T-wall abutments, but the T-projection, instead of being a single solid wall corbelled out at the top wide enough to take two tracks, is made a hollow longitudinal arch in the first case (Fig. 5) and hollow groined arches in the second case (Fig. 6). The plan and front elevations of the two plans are larger, were also worked out. In these cases the side walls are necessarily heavier on account of the greater spans of the arches. The length of the T-projection is less, however, bringing the estimated cost according to these propositions to almost exactly the same figures as for Propositions IV. and V., viz., $23,174.50 and $18,089.50, respectively. In these cases also 20 tons per pile was used for the loading on the foundations.

Fig. 7 shows Proposition VIII. for a U-abutment, the same cross-section being used for the main portion as for Propositions II. and III., namely, a section battered excessively in front to cause the resultant force or load line on the base to pass almost exactly through the middle of the base. In this case, in order to allow the U-projections to be made of less width than would be required by retaining walls of the height in question, they are tied together with a few rods protected by small arches of concrete. The estimated cost according to this plan is $26,636, the loading per pile being taken at 20 tons as in the

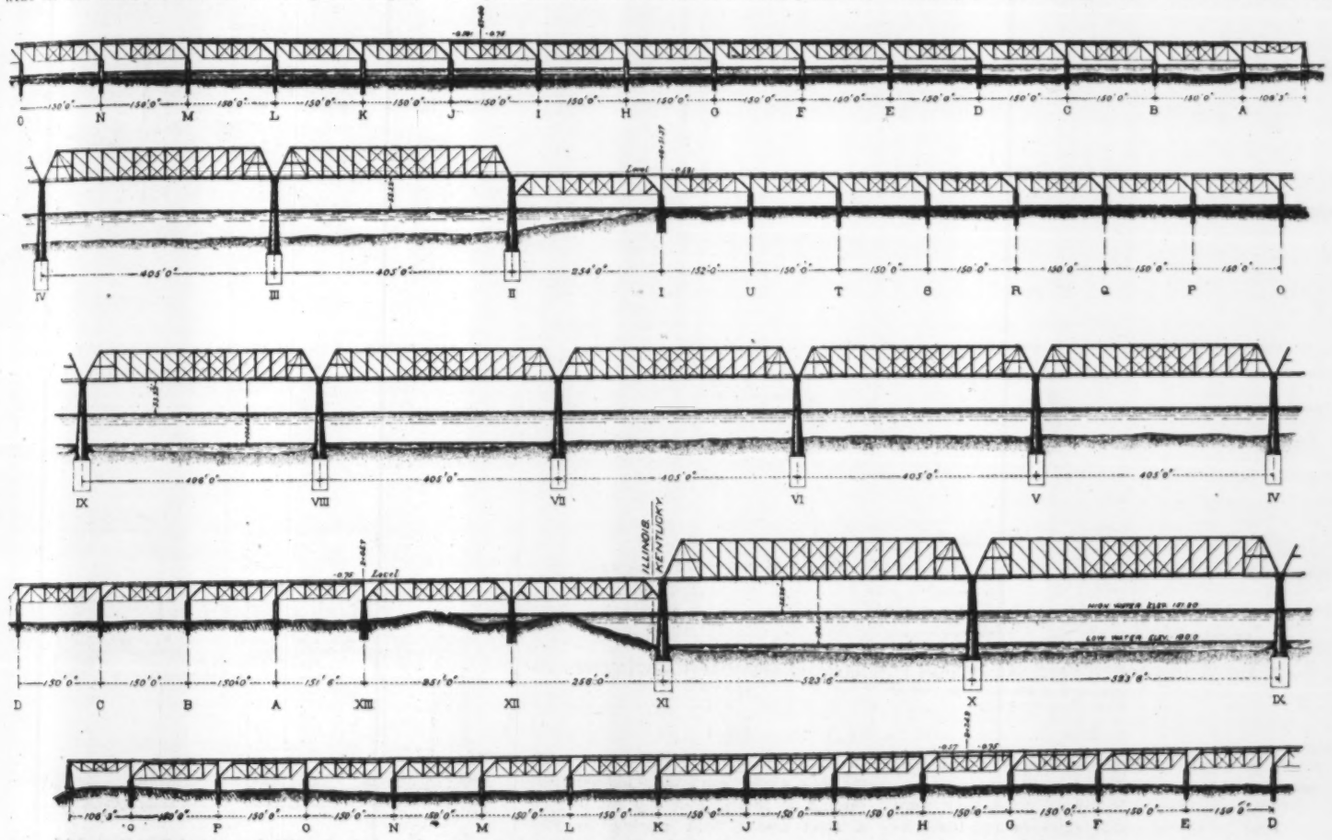


FIG. 1. DIAGRAM ELEVATION OF CAIRO BRIDGE ACROSS THE OHIO RIVER; ILLINOIS CENTRAL R. R.

to resist the retaining wall thrust of the embankment behind. The cost of the abutment on this design would have been, as shown, $37,741.

Fig. 3 shows Proposition II., a more correctly designed abutment for this place, containing both a greater yardage of concrete and a greater number of foundation piles than Proposition I. This plan would give nearly equal loading per pile or per square foot on the foundation as the batter on the face is greater than in the rear, putting the center of gravity of the weight of the pier toward the rear and causing the resultant of this load with the thrust of the earth behind, to pass almost exactly through the middle of the base. The loading per pile is less by this design than for Proposition I., being taken at 20 tons per pile (assuming all the load of abutment, vertical component of earth thrust and dead and live load from the 249-ft. span to be taken by the piles). The cost by this proposition was estimated as shown at $49,241, the unit prices being taken the same as the contract prices on Proposition I.

Fig. 4 shows Proposition III., a plan with the same cross-section for the main portion as for Proposition II. shown in Fig. 3, but in which the wings are made straight with the direction of the abutment, and much abbreviated in their length, identical, and in each case the back ends of the arches are left open allowing the sloping earth to spill into the abutment, thus tying it to the bank firmly and furnishing weight at the rear and to prevent any forward thrusting action of the embankment. For the same purpose a horizontal partition is shown, dividing the height into two parts. This further acts to prevent excessive side pressure on the side walls. The bottom open space is closed at the bottom with an inverted arch to distribute the load over the base. A careful computation showed that there would be almost exactly the same amount of earth fill in embankment by either of these plans, as would occur in case of Propositions I. or II. The same load per pile, 20 tons, is used in these plans as for Propositions II. or III. The estimated cost according to Proposition IV. (Fig. 5), using, on account of the extra form work and on account of a necessary higher average proportion of cement in the concrete, $7.25 per cu. yd. as price for the concrete, was $22,195.50, and in the case of Proposition V. (Fig. 6), using, for same reasons, $7.50 per cu. yd. As the price of the concrete the estimated cost was, as shown, $18,863.50.

Similar plans in which a greater width of T-projection is provided, the arch spaces being other cases, and the price of concrete being taken at $6 as for Propositions I. and II., it appearing that it is about the same average quality and that there is about the same amount of form work per unit as in those cases.

Fig. 8 shows Proposition IX., which is a modification of Proposition VIII. in which the U-projections are much abbreviated, and in which buttresses for strenghtening the abutment and for retaining the earth from the steel are provided towards the front. This proposition requires more extra earth filling than was required by Proposition VIII. In this case, the whole work being so compact it was considered proper to estimate the cost of the concrete at $5.50 per cu. yd. in comparison to the prices mentioned for the other propositions. The unit loading per pile was taken at 20 tons as in the other cases. The total estimated cost of this proposition is $20,161.

Table I. is a statement of the nine propositions mentioned, showing the total cost of each.

Similar studies were made for the Kentucky approach abutment. In this case the pier to be included in the abutment consists of two concrete filled steel cylinders on concrete bases on pile foundations. The estimates, Table I., all included the leaving of these cylinders in place, concreting

TABLE I.—Showing Comparative Estimated Costs of Various Plans for Abutments for Cairo Bridge.

No. of Plan.	Illinois Abutment Plans.	Total Cost.
1.	45° Wing Abutment. Most of batter on back	$37,741.00
2.	45° Wing Abutment. Most of batter in front	40,241.00
3.	Straight Abutment, short wings. Batter in front	27,409.75
4.	T Abutment, 32 ft. 8 ins. wide on top	22,449.50
5.	T Abutment, 32 ft. 8 ins. wide on top. Groined arches	17,976.50
6.	T Abutment, 38 ft. 9 ins. wide on top	23,174.50
7.	T Abutment, 38 ft. 9 ins. wide on top. Groined arches	18,089.50
8.	U Abutment. Batter in front	25,506.00
9.	U Abutment. Batter in front. Forward buttresses	20,161.00

between and around them to make suitable support for the double track six-truss deck span from pier J to pier K. The total height of the abutment in this case is 69 ft. 4 ins. as opposed to 78 ft. in the case of the Illinois approach abutment, so in all cases the estimates of the cost were less than for the Illinois abutment.

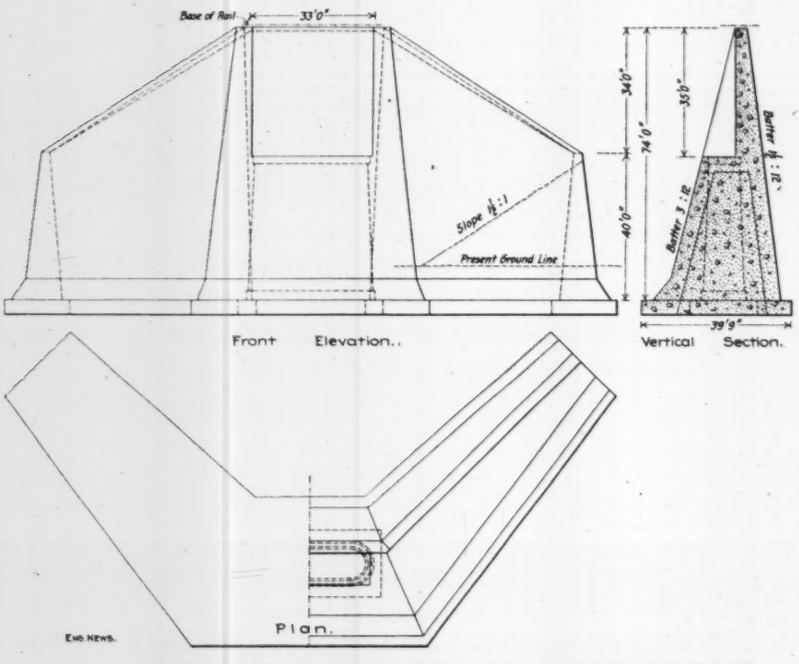


FIG. 3. IMPROVED ORIGINAL DESIGN FOR ILLINOIS APPROACH ABUTMENT.

Concrete, 6,888 cu. yds., at $6	$41,328
Piles, 931, at $8.50	7,913
Total	$49,241

After these studies had been made they were discussed by the railroad engineers and the contractors, Bates & Rogers, and it was decided to withdraw the approval on the contract plans (Proposition I.) shown in Figs. 2 and 9 and to substitute the plans of Proposition IV. shown in Figs. 5 and 10, both on account of the great saving in money and because it was believed that better and better looking abutments would be obtained. It was considered that the groined arch approaches shown in Proposition V. or VII. were a little too radical, though still cheaper than Proposition IV. Personally the writer believes there are many points in favor of massive designs like Prpositions III., VIII. or IX., but on account of the earth action on the floors of the arches in Proposition IV. or the other similar designs, an almost vertical and uniform loading is obtained over the whole base.

Actual work on these abutments has not yet begun, the railroad company officials having postponed that part of the improvement. Much work was done in 1903 as planned. Some of the filling was done, and a high temporary timber trestle was built alongside of the Illinois approach, thus double-tracking it, up to Pier XIII. where the abutment on the Illinois side is to be built. This trestle was designed to use in filling the approach with earth (and this filling is now gradually being done), but it is now being used as part of the double track portion of the Illinois Central, thus shortening the single track part by a considerable distance and expediting traffic to some extent. The arch at Sycamore St. was also built at a cost of about $70,000.

Subsequent to the decision to change the contract plan to the Proposition IV. as above written, a further suggestion was made to do away with an abutment entirely, but, instead, stop the fill far enough back of Pier XIII. so that the forward slope from the end would not spill over the top of Pier XIII. and span the distance from the end of the fill to Pier XIII. by a small girder span. Fig. 11 shows Propositions numbered X., XI., XII. and XIII. for accomplishing this purpose.

Proposition X. calls for a concrete pier on piles to be built from a foundation below the present ground level with its top at the proposed end of top of fill, this top being designed with a back wall to keep the earth from a short 50-ft. deck girder span with ballast floor resting on this pier at one end and on a steel trestle bent resting on Pier XIII. at the other end. Proposition XI. has the same pier in the end of the fill, but instead of using a steel trestle bent support for the Pier XIII. end of the short 50-ft. span, an extension to Pier XIII. of concrete is built, being carried up from the foundation.

Propositions XII. and XIII. use a pile support for the shore end of the 50-ft. span, instead of the concrete pier of Propositions X. and XI., the idea being to build this pile support after filling is completed, and renewing it later with a small concrete pier in the top of the bank, after same shall have settled.

Of these four propositions, Proposition X. seems to be the most rational, and the cost of same would only be $11,039 as opposed to the much greater cost as per plans of abutments according to Propositions I. to IX. above discussed. This $11,039 should really be reduced about $1,200 to less than $10,000 on account of the smaller amount of earth filling required by this scheme.

Many interesting considerations were brought out in the discussion of the relative merits of the different plans, among which should be mentioned the desirability, or necessity, in designing engineering structures, to study alternative, or possible alternative plans. A design made by a subordinate engineer from instructions (rigidly adhered to) from his superior may not be the best or the cheapest or the most advisable from many standpoints, though the subordinate will often receive better recognition for his services on account of following instructions without discussion.

On account of getting work done quickly, designs are often made quickly and with far too little thought, and contracts let thereon before any study at all is made, with the result that great unnecessary expense is met with for accomplishing the results desired by the design.

The writer has been told that in European countries, especially in those countries in which the majority of engineering enterprises are undertaken by the Government or in which the railroads and other public utilities belong to and are controlled by the Government, military discipline practically extends to the drafting room and that the whole question of designing engineering done by a department is apt to be following out the ideas of the head of the department without availing himself of the undoubted native ability of his trained assistants, many of whom undoubtedly could give him points to cheapen or better the designs. In our own country, something similar to this state of affairs is too apt to be the case.

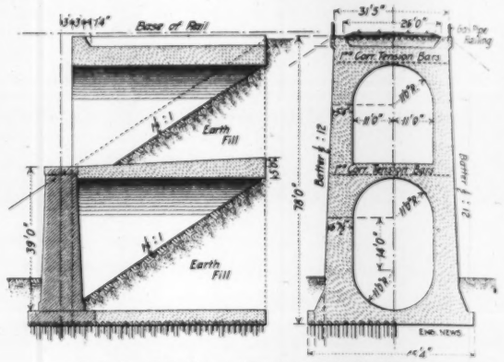


FIG. 5. DESIGN WITH LONGITUDINAL ARCHES; ILLINOIS APPROACH ABUTMENT.

Concrete, 2,660 cu. yds., at $7.25	$19,285.00
Piles, 337, at $8.50	2,864.50
Iron bars	300.00
Total	$22,449.50

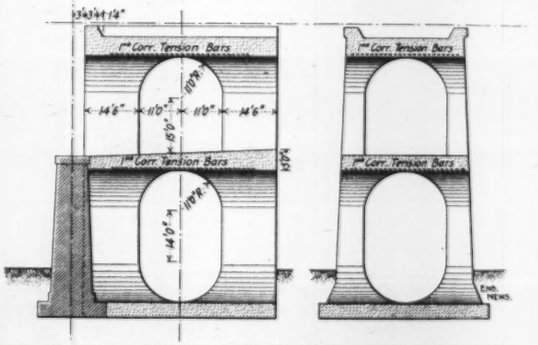


FIG. 6. DESIGN WITH TRANSVERSE AND LONGITUDINAL ARCHES; ILLINOIS APPROACH ABUTMENTS.

Concrete, 1,935 cu. yds. at $7.50	$14,512.00
Piles, 337, at $8.50	2,864.50
Iron bars	600.00
Total	$17,976.50

A successful designer, from an engineering if not from a commercial or salary standpoint, is that engineer who gets all the hints to aid him that he can, whether from superiors, associates or subordinates, or more especially perhaps from foremen or superintendents for contractors or from contractors themselves, from the practical men whose experience is most valuable.

It is doubtful if any engineering structure was ever built the design for which could not have been improved upon. In other words, the best possible design was probably never quite reached by anyone. Therefore every engineer should continually endeavor to see where he can change a design for the better before it is too late.

TRACKLAYING WORK ON THE INDIANA HARBOR RY.

The Indiana Harbor Ry. has now in operation an outer belt line around Chicago, from Franklin Park, Ill., to Indiana Harbor and Osborn, Ill., a distance of 70 miles, but has recently completed building an important extension south from Indiana Harbor to Danville, Ill., 106 miles. This is for the special purpose of giving a direct route into Chicago for the Cairo & Danville and Indianapolis & Peoria lines of the Cleveland, Cincinnati, Chicago & St. Louis Ry.

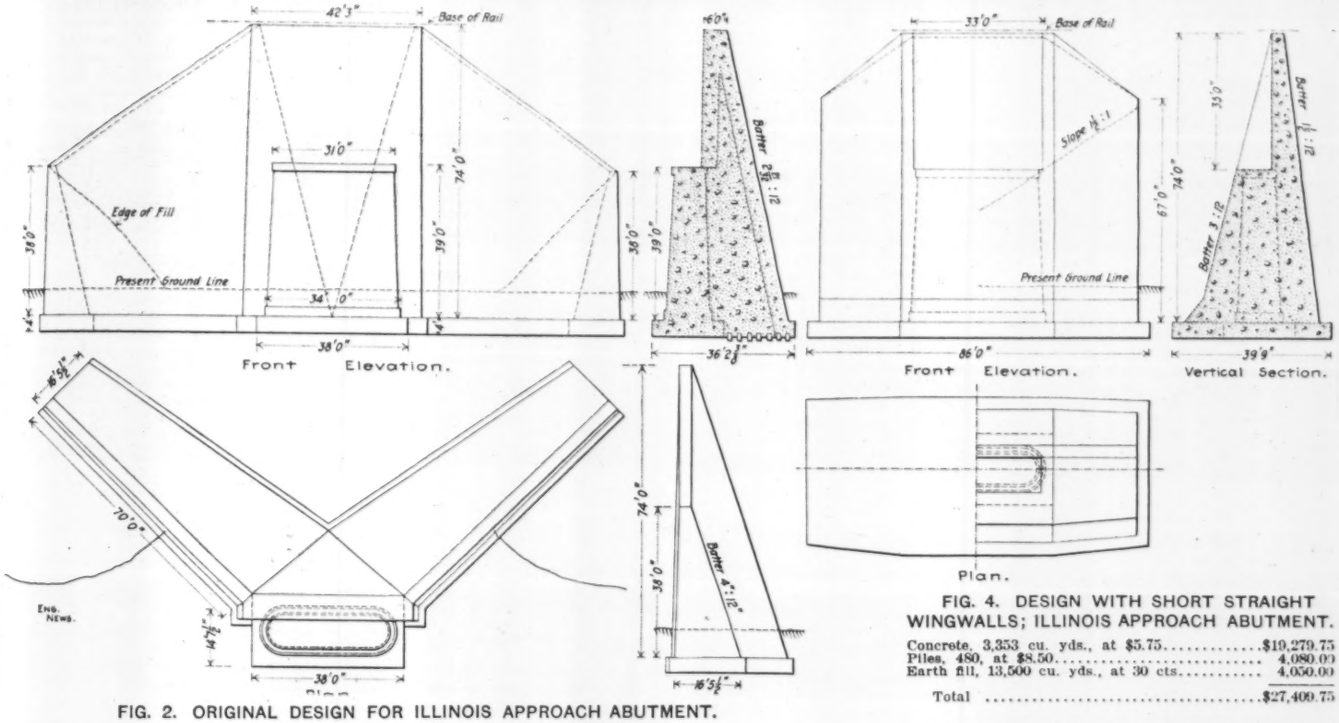


FIG. 2. ORIGINAL DESIGN FOR ILLINOIS APPROACH ABUTMENT.

Concrete, 5,681 cu. yds., at $6	$34,086
Piles, 450, at $8.50	3,655
Total	$37,741

FIG. 4. DESIGN WITH SHORT STRAIGHT WINGWALLS; ILLINOIS APPROACH ABUTMENT.

Concrete, 3,353 cu. yds., at $5.75	$19,279.75
Piles, 480, at $8.50	4,080.00
Earth fill, 13,500 cu. yds., at 30 cts.	4,050.00
Total	$27,409.75

The line passes through rolling country, except for five miles north and 20 miles south of the Kankakee River, and the earthwork averages about 40,000 cu. yds. per mile, owing to the very easy grades determined upon. The line is double track throughout, on account of the amount of traffic to be handled, and has a width of roadbed of 48 ft. in cuts and 32 ft. on banks. The rails used are 30 ft. long, weighing 80 lbs. per yd., and are laid with broken and suspended joints; the joints are spliced with the "100%" angle bars (having a stiffening web below the base of the rails), the bars being 24 ins. long, with four bolts. There is very little curvature, and the sharpest curves are of 2°, so that no curving of the rails is required before they are sent out onto the track. The maximum grades are 18 ft. to the mile on the southbound track, and only 12½ ft. to the mile on the northbound track, the latter carrying the heavier traffic. A notable feature is the arrangement of the ties and tie-plates, to accord with the relative traffic on the two tracks; the northbound track has oak ties, without tie-plates (16 ties per 30-ft. rail); the southbound track has cedar ties, with Dilworth & Porter tie-plates (18 ties per rail). The tracks are 13 ft., c. to c., with gravel ballast.

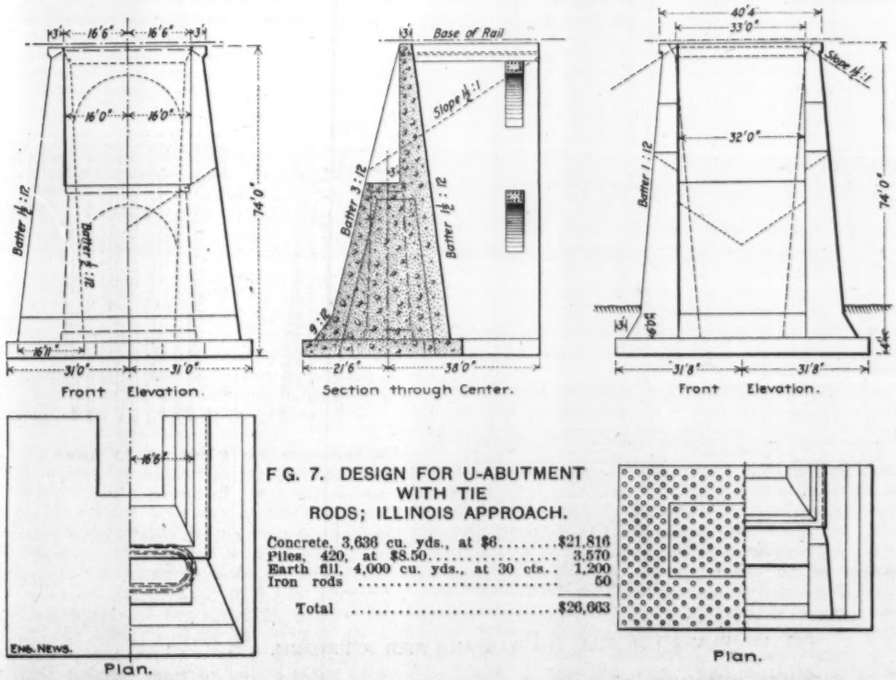


FIG. 7. DESIGN FOR U-ABUTMENT WITH TIE RODS; ILLINOIS APPROACH.

Concrete, 3,636 cu. yds., at $6	$21,816
Piles, 420, at $8.50	3,570
Earth fill, 4,000 cu. yds., at 30 cts.	1,200
Iron rods	50
Total	$26,663

The tracklaying followed about 10 or 20 miles behind the grading, and was done by the aid of a Roberts steam tracklaying machine, built by J. H. Roberts Co., of Chicago. This machine delivers both rails and ties at the head of the train, and no teams are required to distribute the ties. The tracklaying train was made up as follows: The pioneer car, or tracklaying machine, followed by cars of rails, then the locomotive, and behind that the cars of ties. The sidings for materials were about ten miles apart. The track was not full spiked and bolted ahead of the train, but the average progress was about one mile of track per day (full tied, spiked and bolted). The machine, however, was of sufficient capacity for laying two, bolted. The tracklaying gang averaged 100 men and worked 10 hours per day, six days in the week. Behind the tracklaying train followed a gang of 160 men to line and surface the track. The distribution of the tracklaying gang was as follows (average 100

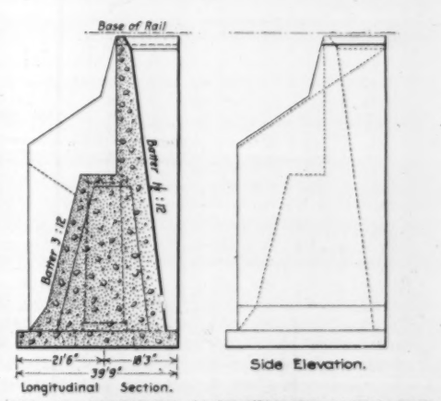


FIG. 8. MODIFIED U-ABUTMENT WITH TIE RODS; ILLINOIS APPROACH.

Concrete, 2,500 cu. yds., at $5.50	$13,750
Piles, 366, at $8.50	3,111
Earth fill, 11,000 cu. yds., at 30 cts.	3,300
Total	$20,160

men), but with a gang of 120 men two miles of track per day can be laid and full spiked:

Distribution of Tracklaying Gang: Indiana Harbor Ry.

(With the train.)	
Foreman	1
Engineman (on pioneer car)	1
Loading ties from cars into chute	6
Loading rails from cars into chute	2
Distributing splice bars, spikes and bolts ahead	1
Receiving and placing ties	12
Receiving and laying rails	11
Strappers putting on splices	4
Tie liners	2
	40

(Behind the train)	
Foremen	2
Distributing spikes and bolts	2
Back spikers	24
Back nippers	12
Back strappers	4
Spacing and straightening ties	6
Lining track	6
	56

The structures are mainly arched openings and plate-girder spans, the arches and bridge piers and abutments being of concrete.

Mr C. W. Hotchkiss is General Manager of the Indiana Harbor Ry., and the Chief Engineer is Mr. R. S. Seymour, to whom we are indebted for information concerning the work described.

TESTS OF THE ULTIMATE SHEARING STRENGTH of various materials were described in a paper read Dec. 15 by E. G. Izod before the Institution of Mechanical Engineers of Great Britain. The author found that hard materials like cast-iron, with little elongation, have a shearing strength exceeding by 20 to 25% their ultimate tensile strength. With fibrous materials which yield greatly before failure, on the other hand, the shearing strength may be anything from 0% to 50% below the tensile strength. It should be said that a special form of testing apparatus was used in which the specimens were stressed in shear only, bending stresses being almost entirely eliminated.

memory of the inspector in the way of points to be observed, and also to reduce to a minimum the amount of writing which the inspector must do. Thus we have printed above a ruled line, and in heavy-faced capitals the words "Yard, Surface" [of], and directly beneath and close to the line, in small roman type, the words, "Earth-Wood-Macadam-Brick-Asphalt-Stone Block." If the yard is paved with asphalt, for instance, the inspector need only put a check mark against the corresponding word. In some cases, however, it will be necessary for the inspector to write in the number, size or condition of the thing being inspected, but here one or two figures, or single word, will generally suffice. Altogether, several hundred possible conditions are provided for record by merely checking the proper word, writing in one or two numbers, or such single words as good or bad. The inspection seems to cover everything one could reasonably desire to know about a school building and its surroundings, from the location, type, material and cleanliness of drinking fountains to the character of the street curbing and pavement in front of the building and whether there is a single, double or no car track in the street. Those interested in securing further details concerning these cards can obtain samples of them by sending a stamp and their address to Mr. Chas. B. Ball, M. Am. Soc. C. E., Secretary City Homes Association, Monadnock Block, Chicago, Ill.

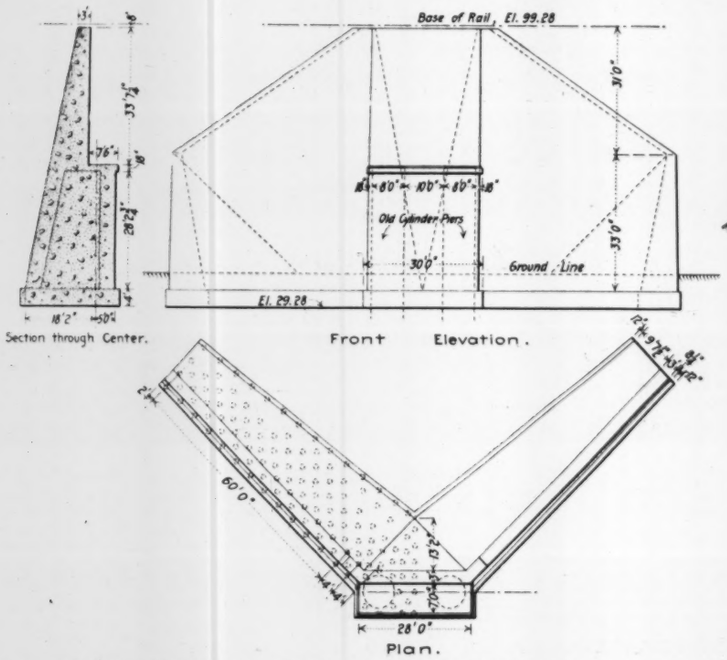


FIG. 9. ORIGINAL DESIGN FOR KENTUCKY APPROACH ABUTMENT.

Concrete, 4,500 cu. yds., at $6	$27,000
Piles, 250, at $8.50	2,125
Total	$29,125

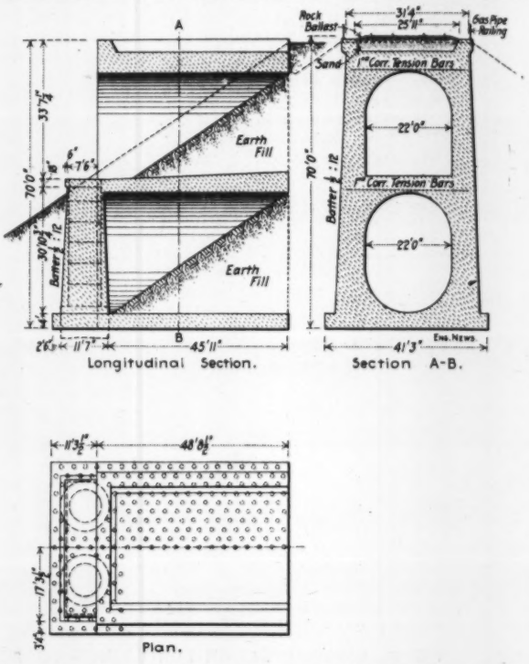


FIG. 10. ADOPTED DESIGN FOR KENTUCKY APPROACH ABUTMENT.

Concrete, 2,632 cu. yds., at $7.25	$19,082.00
Piles, 331, at $8.50	2,813.50
Iron bars	300.00
Total	$22,195.50

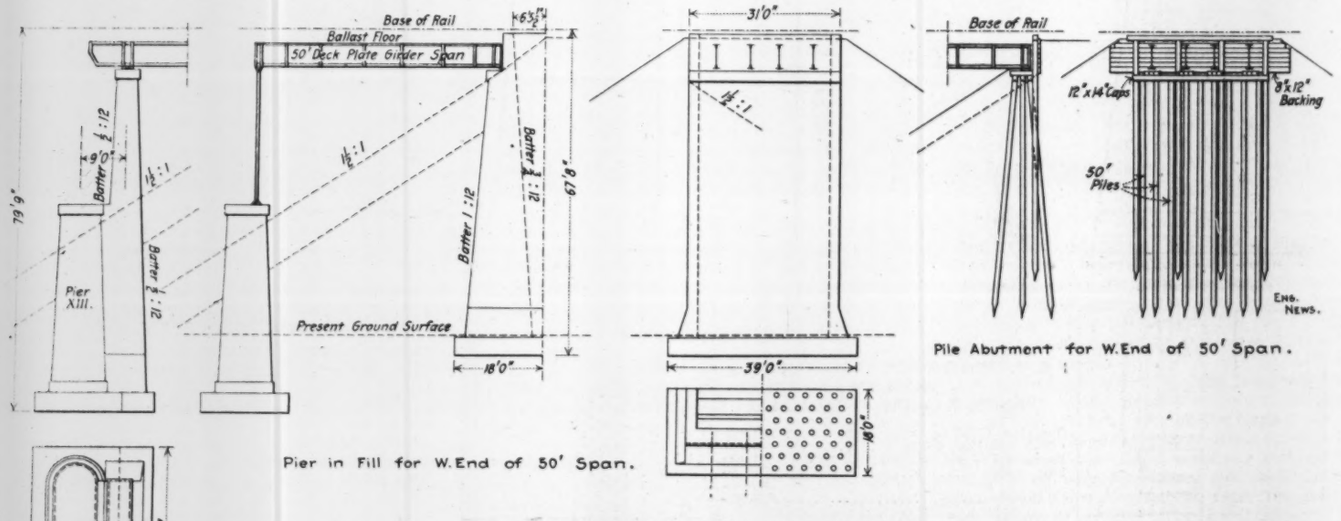

Base of Rail
Ballast Floor
50' Deck Plate Girder Span
Present Ground Surface
Pier XIII.
Pier in Fill for W. End of 50' Span.
Base of Rail
12"x14" Caps
8"x12" Backing
50' Piles
Pile Abutment for W. End of 50' Span.
Pier for 50' Span behind Pier XIII.

FIG. 11. PLANS FOR PILE TRESTLE AND PIER APPROACH.

A SANITARY INSPECTION OF CHICAGO SCHOOL buildings is proposed by the City Homes Association, with the approval of the Board of Education. To record the results of the inspection, cards, 8 ins. long and 5 ins. high, have been ruled and printed on both sides. The plan of these cards is to leave as little as possible to the

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On Monday, Jan. 8, the new transcontinental mail schedule went into effect, by which the round trip time of the fast mail service between New York and San Francisco is reduced 48 hours. It is now for the first time possible under this schedule to mail a letter in New York City to San Francisco and receive a reply within seven days. The fast mail train leaving New York at 2.45 a. m. on Monday is due at Chicago in 18 hours and at San Francisco on Thursday noon. A reply mailed before 6 p. m. is due to reach New York City at 9.30 a. m. on the following Monday.

This improvement in time has been made possible partly by the 18-hour fast mail trains between New York and Chicago, but chiefly by improved facilities for sorting mail en route and prompt transfers. Of course the faster regular schedules of the transcontinental railways, which have been made possible by the permanent way improvements of the past four or five years, are also an important factor.

In the public discussion of very high railway speeds, it is commonly held that the chief benefit of such speeds is for the rapid carriage of passengers. As a matter of actual fact, however, the number of passengers who are actually benefited by extraordinarily high railway speed is exceedingly small. Take, for example, the 18-hour trains between New York and Chicago, which enable a business man compelled to travel from one city to the other to save a part of one day of working time. Credit this saving at its greatest value and it is really a mere trifle compared with the public benefit represented by a saving of six hours in the time of transit of perhaps a million letters and other forms of mail matter carried at every trip of these fast trains.

A fight against the use of concrete in the building trades, except under restrictions that rob it of a large measure of its economic advantage over brick or stone masonry, is now being made by the labor unions in some sections of the country. Not content with existing rules to the effect that concrete must be mixed and placed by men classed and paid as mason's helpers, the unions of Essex Co., N. J., now insist that the concrete shall be dumped on a mortar board and placed with a trowel; or in effect, that concrete must be put in place by a mason. In Newark, the largest municipality in the county named, reports have it that the bricklayers insist on placing all concrete themselves, to the exclusion of stone masons, but this seems too unreasonable for belief, or at least to have any promise of being carried to a successful issue; for it is not likely that the stone masons will allow the bricklayers to monopolize concrete work.

Leaving out of account the controversy as to whether brick or stone masons place concrete, the practical effect of the new rules, in some of the smaller municipalities of Essex County, is to advance the labor cost of concrete from $1.75 to $3.20 per day for mixing and for moving to place, and from $1.75 to $5 per day for putting it in the wall. The prices given are the wages for an eight-hour day, paid to ordinary laborers, to masons' helpers and to stone masons, respectively, allowing for contractors' profits. Union rules aside, as our readers well know, common laborers can do practically everything required on concrete work, under the direction of a competent but not high-priced foreman. Every one interested can estimate for himself, in accordance with local conditions, the great increase in labor cost due to excluding common labor from concrete work and to insisting on having a mason place the concrete in the forms. For our present purpose, the exact figures are of no importance, since both they and the principle involved are so great. The principle at stake, obviously, is an attempt, already successful in some quarters, to dictate, virtually, whether one material or another shall be used in building construction, and if a choice is exercised by the owner to compel him to pay an unnecessarily high price for it. The new rulings differ little in object and effect from the old efforts, unfortunately not yet ceased, to prevent the substitution of machinery for hand labor. They cannot and should not succeed in this case any more than in that, for in each they are against economic progress and individual liberty alike, increase the cost of living generally, and thus and in other ways militate against the interests of the very men who try to make and try to enforce such restrictions.

There was once a man with a distinguished name who went to Cuba as a war correspondent and who sent home harrowing accounts of the sufferings undergone by the brave officers of the U. S. Army because, through the blunders of our stupid government, a change of undershirts was not provided on time!

We are reminded of this incident by the sensational reports which another newspaper correspondent with a distinguished name recently sent up from Cuba, and to which the New York "Herald" and other reputable papers gave wide circulation last week. These are the "scare" head-lines which the "Herald" placed above Mr. Poultney Bigelow's letter:

COLON A REPROACH TO ALL AMERICANS.
City of Filth and Disease, a Pest Hole and Death Trap Because of Neglect.
Fair Promises Are Broken.

With this introduction Mr. Bigelow proceeded to describe in graphic language the unsanitary condition of Colon and to place the blame for this condition upon the canal administration. As a result the daily papers have been full of editorial diatribes, all based on the idea that Mr. Bigelow had made a new discovery at Colon, and one which proved the incapacity of those in charge of the work at Panama.

But did Mr. Bigelow make any new discovery? We respectfully request the intelligent newspaper editors who have been hurling maledictions at the canal administration to compare the statements in Mr. Bigelow's letter—the statements, mind; not the opinions and insinuations—with the official report of the Isthmian Canal Commission, made public on Dec. 29.

Mr. Bigelow says: "The condition of Colon is a disgrace to civilization." The Commission (p. 44) says: "The present condition of the streets of Colon is intolerable." Evidently, then, Mr. Bigelow made no new discovery. The condition of Colon was not concealed by the Commission, but was explicitly stated in its official report, made public before Mr. Bigelow's letter.

And in that report we find also the reasons stated why the complete sanitary renovation of Colon has not been undertaken. The city of Colon stands on a swamp. It adjoins also the town of Cristobal, all the property in which belongs to the United States, and at Cristobal a large proportion of the offices and residences of the United States employees are located. The Commission has done much work at Cristobal for permanent sanitation, and its streets have been placed in fair condition. In order to place Colon in really sanitary condition, it will be necessary to raise the grade of the city by filling the swamp, which might be done economically at a later date with dirt from the canal excavations, but would involve great expense if done at the present time.

There is, however, another important reason why the sanitary renovation of Colon has been delayed. The Commission says:

> It was not considered wise to enter upon this work until the plant of the canal was definitely determined and the Atlantic entrance fixed. Should a straightaway entrance be determined upon, it would necessarily be to the westward of Mindi Point, and consequently a few miles distant from the town of Colon. Should the Panama Railroad thereafter move its Atlantic terminus to the canal entrance there would be little, if any, excuse for maintaining the town of Colon at its present location, and should the town grow toward the new location or be removed to that point, the large expenditure necessary to fill, drain, and sewer the present location would be avoided.

Instead, therefore, of the situation at Colon "bringing reproach on American engineers," as Mr. Bigelow charges, it would appear that the Commission has actually exercised a wise discretion. Already the Commission is being severely criticized for spending so much money on preparatory work prior to actual digging. One can easily imagine the scathing condemnation which Mr. Bigelow and other newspaper correspondents would award to the Commission for wasting the taxpayers' money if Colon were to be transformed at great expense and then a few years later be abandoned.

But the Commission has not utterly neglected Colon. A report was made in September upon the best means for temporary improvement, and work is now in progress on filling the streets and draining by open ditches, of which 15,000 ft. are being dug. This is believed to be all that the Commission is justified in doing until it is known whether the town is to remain where it is or be abandoned.

We hold no brief for the canal administration. Without doubt it has made, and very likely is still making, some mistakes. If it were wholly inerrant it would be more than human. Where it makes mistakes it, of course, ought to be criticized; but it ought not to be convicted in the public mind of incompetency on the testimony of a sensational newspaper correspondent, whose statements, when sifted, convey nothing more than what has already been made public officially by the Commission itself.

The care and relief of persons injured in railway accidents is a matter that, as a general thing, is given very much less attention in railway service than the matter of clearing the wreck and opening the line to traffic. This is not due to any lack of humanity, but rather to the fact that this latter necessity is much more strongly impressed upon the minds of officers and employees alike. At important towns, arrangements are usually made by which medical attendance can be secured when required, and the tool car of the wrecking train is sometimes equipped with stretchers, bandages and blankets, or even with a small medicine chest. In most cases, however, there is delay in preparing a relief train, and in getting doctors and nurses (with their equipment) to the scene, while the supplies and facilities are usually very inadequate, as the inevitable result of haste in getting the materials together in an emergency. Practically every railway and every division of an important railway has its own complete wrecking equipment and organization. At the terminal or division point is a derrick car, tool car, etc.; and arrangements are made to have an engine always in readiness and men to form the crew whenever an alarm signal is given. Whenever a wreck occurs this train is hurried to the scene and the work of clearing the wreck is taken in hand at once. But the persons injured, employees and passengers

alike, have frequently to remain unsheltered and untended for a considerable time, and are then perhaps given insufficient treatment and transported to the nearest town in freight cars or ordinary passenger cars whose jolting may cause intense suffering. In fact, many of the after-results of train accidents are considered to be due to the exposure and the delay in receiving proper treatment.

A few railways, however, probably not more than half a dozen in all, have made a small beginning in the establishment of hospital cars, to be kept in readiness at terminals or division points and sent out promptly to the scene of an accident. These cars are designed for the care and comfort of patients, are specially well fitted with springs to give an easy riding motion, and are fully equipped with all medical and surgical accessories. An operating table is usually provided for serious cases, but in general the car is usually employed only for minor and temporary treatment necessary to enable the injured persons to be transported in safety and comparative comfort to the nearest place where permanent hospital accommodation is available. In another column we describe two such hospital cars, one of which (built by the Southern Pacific Ry.) has only recently been completed and was an "exhibit" at the Chicago meeting of the American Railway Association in October. This car is exceptionally elaborate and expensive, but it is the intention to build other and less elaborate hospital cars to be stationed at different points on the company's system. While much is being done to increase the safety of railway travel, it would seem that railway companies might well give more attention to providing hospital or relief cars and perfecting methods of giving prompt and adequate relief to persons injured in railway accidents.

The importance of the commercial element in engineering work is not always as fully realized as it should be by engineers. Young engineers especially often have the idea that engineering is a purely scientific matter, entirely independent of and superior to commercial considerations. It has been shown many times that unless the engineer realizes the close relation between his work and the dollars-and-cents test of the business world he is not likely to be successful. An excellent illustration of the importance of the commercial side in modern engineering work is afforded by the article on the new Milwaukee gas works which we publish in another column. It might at first seem that the engineer's work was accomplished when he had designed and built a plant for the manufacture of gas, with a system of mains for its distribution to consumers. But we find that this is only one part of his work. Having produced and distributed the gas, he turns to the means for developing its uses. He investigates the subject of lamps and lighting, and devises improvements in burners and apparatus, with a view to popularizing the use of gas and to effectively meeting the competition of electricity, in economy as well as in general efficiency. This includes both indoor and outdoor work, factory and domestic lighting, with either open burner, gas-incandescent or gas-arc light, as may be most suitable in each particular case. The question of enlarging the field of gas consumption for power purposes is another important matter, and much has been done to encourage the use of gas engines for a variety of purposes, mainly in small units for operating machinery.

This in turn led to the investigation of the possibilities of the use of gas in the numerous industrial and manufacturing plants of Milwaukee. It has been found that gas fuel can be employed to advantage in a variety of processes, and every effort is made to secure its introduction. Special devices and appliances have been designed, in many cases under the direction of the gas company's engineering department, instead of leaving this to be done (or more probably left undone) by the consumer. The result is in very many cases greater efficiency, convenience and economy than before in the use of gas. The success which has attended this special line of work is indicated by a long list of processes in which gas fuel is now extensively employed.

There is still another field to be exploited, and that is the utilization of the by-products. The coke is readily sold, and the recovery of ammonia is comparatively simple, but we find the Milwaukee company also treating its tar, and from it manufacturing paints, shingle stains, creosote for timber preservation, and other articles, which it puts upon the market as a side line to its gas supply business. In all this work of development the engineer is prominent, and he may often be of even greater value to his employer in this field than in the purely constructive work which is more commonly allotted to him.

DESTRUCTIVE CLAUSES IN THE NEW DENVER BUILDING LAW.

Municipal building laws affect such extensive interests and influence so large a part of engineering practice that their strength and their excellence are of wide concern. We say "strength," because to be effective a building law must primarily be strong as a law. We say "excellence," because the very object of such laws, namely, to procure safe, convenient and yet economical construction, depends upon well-chosen, definite and impartial statement of what construction is permissible and what is not permissible. Most municipal building ordinances represent more or less close approximation to these fundamental requirements.

A notable exception, however, appears in a new building code recently put into effect in Denver, Colo., which exhibits a startling absence of effectiveness. A brief review of some of the more striking defects of this ordinance cannot fail to claim the attention of engineers interested either in municipal engineering or in building construction.

The Denver law, adopted by the City and County of Denver last year, is a long and elaborate document, intended to cover all classes of building operations. It defines the word "building" rather humorously, thus:

> Section 515. Any structure erected by art and fixed upon or in the soil, composed of several pieces and designed for use in the position in which so fixed.

Thus the ordinance appears to relate to all constructions from a telegraph pole to a sewer-pipe or a rail fence. Actually, of course, its scope is somewhat narrower. It is, like other building codes, a combination of police ordinance and technical specification. It designates for its enforcement a Building Inspector to be appointed by the Mayor, and establishes the duties and powers of this Inspector. It defines fire limits or zones and describes the kind of building construction which will be permitted in each of the several zones. It calls for certain aisles, stairways and fire-escapes, etc., etc., in certain classes of buildings. It prescribes quality of material and workmanship, gives data of design, fixes loads and stresses, specifies mixtures of concrete, etc. It establishes the procedure to be gone through by owner, architect and builder in constructing, altering or repairing a building. Broadly speaking, it establishes rules for all phases of building construction in the interests of public safety, fire protection and public health.

The Building Inspector is the official who executes this ordinance and watches over its enforcement. His chief weapon is the "building permit," which is a condition precedent to the commencement of all construction of repair work. This permit (Section 18)

> shall be a guarantee that all loads, strains and all other computations have been checked over and corrected by the Building Inspector before said permit was issued.

What does this provision effect? If it means anything it means, in substance, that the Building Inspector shall check over and *make correct* all designs for all buildings erected or repaired. Why is the municipality, through a public official, charged with work that architects and engineers are paid to perform?

It is reasonable to assume that this provision was drawn to further public safety, by requiring the Inspector to examine all parts of every building design in utmost thoroughness. We cannot assume that it was intended to shift the whole responsibility for the sufficiency of a design upon the public authorities; for, while the law definitely attaches such responsibility to the Inspector, and the courts would doubtless recognize this responsibility, yet the provision quoted does not relieve the designer from an iota of responsibility, nor would the courts recognize such release even if it were laid down in the ordinance.

But the unfortunate influence of this provision upon the practice of building design will, it is to be feared, be just the same as if the law specifically released the designer from legal responsibility for the safety of his work. The unscrupulous architect, builder, engineer (if there be any of the latter), who is willing to take long chances and who endeavors to produce the cheapest possible designs that will pass the Inspector, will take this attitude: "The law requires the Inspector to check over and correct my design, and his permit will be a guarantee. I may just as well cut the material 20% below the practice of the other fellows, and take my chances with the Inspector. I run no risk in any case; if he passes the design I have my competitors beaten on cheapness, and if he puts in more material he can at most make it as expensive as the other fellow's design. I have no responsibility in the matter!"

Will anyone who is familiar with building practice deny the probability that this will often occur under such a law? To such a one, if he exists, we need only point to the records of the Darlington case in New York City, which revealed one continuous story of throwing scruples and good practice to the winds, with but one idea in mind: to pass the Building Department. That story, isolated in its terrible sequel, is commonplace enough in all its preceding chapters.

In commenting on the Darlington case we argued strongly that the newspaper clamor to make the New York Bureau of Buildings responsible for the accident rested on fundamental error; that there was no warrant in either common sense or engineering sense for any stand but this: that we must look to the professional man, the designer or consultant, and to him only, for safety against improper construction. At that time we spoke against nothing more serious than newspaper arguments and views. Now we find that these same faulty views have been incorporated in the building law of a large city.

As a matter of fact, the Denver law is worse than the above would suggest. If the Inspector, equipped with adequate powers by the law, were to administer his office with vigor, the above provision might ever remain harmless. Even a weak Inspector, with ample powers, would probably largely neutralize the vicious tendencies of the provision, by the care born of explicit responsibility. In either case no harm to the public would be likely, other than the large useless expense of checking and correcting all computations in connection with all plans for all buildings proposed to be erected or repaired. But the case is otherwise: the law openly and completely emasculates the Building Inspector; it makes his powers illusory, and places instead some fragments of power into the hands of other, but irresponsible, departments of the city government. Two clauses of the ordinance effect this, of which we direct special attention to the first:

> Section 12. The Building Inspector shall have power to pass upon any question arising under the provisions of this ordinance, relative to the manner of construction or materials to be used in the erection, alteration or repair of any building; Provided, however, that should any question arise between the Building Inspector and the owner and architect of any building, or should the owner or architect object to any order or decision of said Building Inspector, the matter shall be referred to a committee of three persons, one of whom shall be chosen by the Building Inspector, one by the owner or other interested party, and the third shall be a member of the Board of Public Works, and the decision submitted by this committee shall be final. Each member of this committee shall be entitled to a fee of five dollars for each day they shall act on this committee. Half of these fees to be paid by the City and County of Denver and the other half by the owner or agent.
>
> Section 36. Any building specifically mentioned, described or listed in this ordinance may be erected in any fire district when special ordinance or permit for same has been passed or approved by the council.

Less importance attaches to the latter clause,

because it concerns only exceptional cases, and will probably be invoked but rarely. While it opens wide the doors for political work and favoritism, yet it does little more than make legal provision for what is likely to be occasionally done, though in another manner, even without the legal provision. But the first clause, Section 12, has the practical effect of robbing the Building Inspector of all power.

The Building Inspector has the power "to pass upon . . . provided" it pleases owner and architect. He may make decisions, provided they please the owner and architect. He may, evidently, make decisions anyhow, but it would be only a waste of breath; the arbitration tribunal steps in to make the real decisions. The Building Inspector is the mere clerk of the arbitration triumvirate, the clerk not of a fixed board, but of a shifting incorporeal possibility, in which he has a one-third voice.

One man makes the decisions of this tribunal; the Inspector and the Owner, both members of the tribunal, either themselves or by proxy, are already paired against each other, and the decision evidently rests with the third. What will he do? The third man is a member of the Board of Public Works, selected from that Board by an unspecified procedure, but in all likelihood a political office-holder. Before him as judge there stand A, the Inspector, who alleges the Building ordinance and his official judgment, and B, the Owner, who cries that he is being hounded by the Inspector and bankrupted by his fanciful and arbitrary rulings. The Inspector stands on the law, or on his view of the law; the Owner stands on his respectability, his position in the world, his influence, his architect's ability, the Inspector's inexperience and financial irresponsibility. Who wins?

It is not, however, the decisions actually rendered by these arbitration tribunals that will work the mischief. It is rather the powerless condition of the Inspector, his constant feeling that his decisions do not count. When did a subordinate, a clerk, ever have the confidence and firmness to follow out his duty independently and courageously (unless, indeed, he were sure of his superior's support) against the claims of powerful, influential opposition? Even assuming fullest honesty and excellent intention on the part of the members of every arbitration board, must not this constant dependence upon, or threat of, a higher authority make the Inspector feel unable to examine and judge independently or decisively?

The Owner, on the other hand, comes before the Inspector with added confidence in the strength of his cause. Is there anything questionable in the arrangement of stairs or fire-escapes, in the structural design, or the like? The quickest possible solution is by appeal to the arbitration clause. It's cheap, too; the matter can be settled by the arbitrators in one session of half an hour, and it costs him only $7.50 for the whole proceeding. There's $50 or $500 or $5,000 to be saved. What's the use of bothering with the Inspector; he may be neglected, except as a step toward the arbitrator's decision! Under such circumstances conscientious enforcement of the law would be remarkable; it is inevitable that the Inspector will accommodate himself to the pressure, and will apply the law with the most extreme latitude to which he can reconcile his professional conscience (the Inspector is to be an architect or practical builder of not less than five years' experience").

Are these the conditions which a reputable building law is intended to create? Surely not! If the "law" part of a building law has any purpose at all, that purpose is to prevent or eradicate just such chaotic conditions of irresponsible building construction as are above sketched, and to establish an orderly procedure for impartial enforcement of the specified restrictions. The Denver law appears well calculated to carry out a diametrically opposite purpose: to establish an orderly procedure for non-enforcement of the ordinance.

One safeguard remains, which may be relied upon to furnish at least some, though erratic, protection: the safeguard of publicity, of public record. The plans of buildings being erected or recently erected are on file in the Office of Buildings, and any citizen, any architect or builder, is able to go there, inspect those plans, verify the application of the law, and obtain certainty that, even if he himself has been unjustly treated, there has at least been no discrimination in favor of his neighbor or his business competitor. In the delicate matter of public building control this publicity, the open condition of recent records, is exceedingly important. No building department in the land, no person actively concerned in building work, but will confirm this.

The Denver building law recognizes the public-record characteristic inherent in the work of the Building Inspector. It provides that

(Section 3) electric wiring and plumbing reports shall be *entered of record* in his office.

(Section 14) rough sketch plans of any proposed building, for reference or *to place on file* in this department *on account of plans or specifications being incomplete*, indistinct or impractical, may be made by the Inspector and charged at the cost of one dollar.

(Section 93) permits for temporary staging shall issue only after complete plans and specifications have been *filed in his office*.

(Section 464) there shall be *filed* in his office *as a matter of record*, plans and specifications for elevators which it is proposed to instal.

(Section 16.) All plans and specifications of buildings of a public character shall *remain on file permanently* in the Building Inspector's office.

Thus, the record feature is acknowledged, since it is applied to public buildings, stands, and details of private buildings. But how is it applied in the important case, the building which a private owner desires to erect? Read Section 16:

> In all cases plans and specifications, sufficient to enable the Building Inspector to obtain full and complete information as to the character of the work proposed to be done under the permit, shall be filed with the application for permit, and if the cost of the work is to exceed fifteen hundred dollars, complete plans and specifications, showing and describing all parts of the construction, shall be submitted, and upon the issue of a permit a true copy of said drawings and specifications, signed by the architect or owner, shall be filed in the Building Inspector's office and remain on file there until the completion of all building operations had under said permit, when they shall be returned to the party who filed them; such plans and specifications shall not be open to the inspection of others than those interested in the building or structure, and if not claimed by the proper party within three months after completion they shall be destroyed.

In other words, not only shall there be no *permanent* record file of plans to which buildings have been erected, but every care is taken to state explicitly that at no time shall there be such public record even *temporarily*! Three months after a building is completed the law says there can be in existence no plans or specifications of a building, other than such as the architect or owner may have kept or may have given to others. If there was anything wrong in the plans, anything unlawful or unsafe, all evidence of it as far as the building office is concerned is destroyed! The Building Inspector is held by the law to guarantee a construction for which permit he issued (whether voluntarily or issued by mandatory injunction of a court!), but thirteen weeks after a building is completed it may collapse and no evidence lies on record in the Inspector's office by which this guarantee, this responsibility, may convict him of negligence or malfeasance. The law then must go to the architect's drawings and records. The architect, however, will be held by the law to be equally responsible for faults of his design; will he have records of plans and specifications on hand if the public investigator calls for them? Or if he has lost or destroyed his records, will he remember the questioned details of the construction?

Nor may one architect, owner or builder inspect the plans for similar structures for which permit has been issued to another architect, owner or builder, even though the building be yet uncompleted and the plans therefore still on file. The file is expressly closed to him. He might, it is feared, obtain therefrom information which would work injury to the "party who filed them." Was the law applied strictly or loosely in that case? Was a deviation permitted, or a broad exception of the law made? He shall not go to the "filed" plans to find this out. He could thereby only harass the Inspector or the architect, or work injury to "those interested in the building or structure."

The remarkable clauses above quoted form an iron ring to circumscribe the effectiveness of the Denver Building Ordinance and in fact make it a dead letter. First, the architect and owner are freed from moral responsibility for decent design and obedience to the provisions of the law; the Inspector must guarantee the plans with his permit. Second, the Inspector is rendered powerless, a figurehead, by the "arbitration" clause. Third, all evidence of what was done is sealed to others than "those interested in the building." Lastly, as soon as the building is completed, all evidence is destroyed so that even a Court cannot reach it.

The building law, in theory, is for the protection of the public, and its restrictions must in theory be strictly and impartially enforced. Can a law with the above-quoted clauses give such protection, or secure impartial enforcement of the law? We have no hesitancy in asserting that under that law, with an unscrupulous political ring in power, a favored architect can monopolize the architectural practice of the city, a favored builder can grasp every desirable building contract, and a favored owner can become real-estate king of the city. The protection of the public is lost to sight.

LETTERS TO THE EDITOR.

The Design of a Temporary Bridge with Pontoon Draw Span at Chicago.

Sir: In reference to your description of "a temporary bridge with pontoon draw span over the Chicago River" in your issue of Dec. 28, the following additional remarks may be of interest.

The first bridge of this kind was proposed and designed by me in April, 1902. The general arrangement of this bridge and the details of its turntable proved to work so satisfactorily that they were adopted for all new bridges of this type built by the city of Chicago. In choosing the system for the trusses I decided not to follow the usual practice of arranging compression (timber) diagonals and tension vertical rods, but preferred timber verticals and steel diagonals. For pony through bridges this arrangement has the advantage of furnishing stiff supports for the top chord against side pressure without skew or other complicated timber connections. A second advantage is the absence of any butt-joints between diagonals and skew backs. This is rather important for a movable bridge, as such a bridge may get a knock from the side at any time, and during its operation is exposed to irregular impacts and vibrations. A span with bolted connections throughout offers a fair resistance in any direction and will stand vibrations or an occasional collision without much damage.

Yours truly,

Alexander von Babo, C. E.

1830 Arlington Place, Chicago, Jan. 2, 1906.

Vibrations in Large Gates for Deep Reservoirs.

Sir: It is frequently stated that large gates, especially when opened under considerable head of water, are subject to the most violent trembling and should be avoided. The writer has never observed this at gates discharging into the open air with moderate pressure and cannot see any reasons why this should take place under great head.

Frequently high-pressure gates are located in tunnels and have gate-chambers somewhat widened below the gate-frames, and the latter are often considerably narrower in area than the tunnel. No doubt, in these cases suction exists tending to create a partial vacuum next to the gate, with the consequent vibrations in the same way as at an overfall weir with a too steep face downstream. In order to do away with such a defect in a gate-chamber a small vent-pipe, connecting the same with the outside air would probably be entirely sufficient. Possibly some of your readers may be able to make, from their experience, a statement to the contrary.

Very respectfully, Charles R. Steiner,

Asst. Engr. U. S. G. S., Pathfinder, Wyo.

Pathfinder, Wyo., Dec. 27, 1905.

(The chattering of a partially opened gate past which water is escaping under high head is like other cases of vibration, sometimes difficult to account for. We do not think, however, that a partial vacuum is necessary to cause such chattering; and therefore a vent-pipe would be by no means a certain preventive.—Ed.)

Questions on the Strength of Bins and Reservoirs.

Sir: Much has been written about how to calculate the pressures of different materials on the bottoms and the sides of bins or reservoirs, but I can't remember to have seen anything about the calculation of the stresses caused by these pressures; and a practical example of calculation for fixing the dimensions of the sides and the bottoms which will withstand these forces with a certain factor of safety. Nowadays reinforced concrete is very extensively used for these structures, which as a combination of two materials makes the matter more complicated; notwithstanding, practical formulas based on scientific principles can be worked out and are very urgently needed. Among the questions which must be settled are: 1. Is the bottom of a reinforced concrete bin a plate fixed all around the circumference? 2. If so, how shall the reinforcement be distributed to correspond with all the theoretical as well as practical requirements? 3. Are the sides to be calculated as plates fixed along three sides (as the top is often free)?

Civil Engineer.

Kansas City, Mo., Dec. 30, 1905.

(The best way, it seems to us, is to adopt such designs that complicated methods of computation involving large uncertainties in their practical application will not be required. Instead of supporting the bottom of a bin at the sides alone, support it at all parts by columns or by girders and beams. As for the stresses in the walls, if circular bins are used there will be nothing but tension in the concrete due to the bursting pressure of the grain.—Ed.)

The Relative Economy of Rope and Electric Transmission: a Challenge.

Sir: In the spring of 1904 the engineer of our transmission rope department read a paper before the New England Cotton Manufacturers' Association, showing the relative cost of rope, belt and electrical drives in cotton mills. This paper brought forth considerable criticism at the time, the most severe coming from partisans of electrical transmission. Our reply to this criticism was the following offer, which was printed in practically all of the technical and trade papers of the United States:

The American Mfg. Co., of 65 Wall St., New York, will agree to furnish the necessary rope sheaves, rope and driven head-shafts, for the main drive of any cotton mill using 500 HP. or more, developed at the mill site, at one quarter the price for which any responsible company, furnishing electrical apparatus, will agree to install generators, motors, motor shafts, switchboard, wiring and other appliances necessary to electrically transmit the same power.

Where the power is generated at a distance from the mill site, if the mill will install the central motor, the American Mfg. Co. will agree to distribute the power from same to the main line shafts, by means of rope drives, for half the cost of electrical apparatus to distribute the same power.

This offer is made to any cotton, woolen, paper or similar mill in the United States.

It is sixteen months since this offer was made. So far, no manufacturer of electrical apparatus has come forward to take up the challenge. We wish now to repeat the offer, with the following addition:

We will guarantee to any cotton, woolen, paper or similar mill using 500 HP. or more a saving of 25% in fuel consumption in favor of rope drives over any electrical equipment that can be installed, the same engine being used for both transmissions.

Further, in case we fail, we will remove our apparatus without expense to the mill owner, and pay a forfeit of $10,000 to cover loss and inconvenience to the company making the trial, provided any concern furnishing electrical appliances will take the other side of the proposition and duplicate this offer.

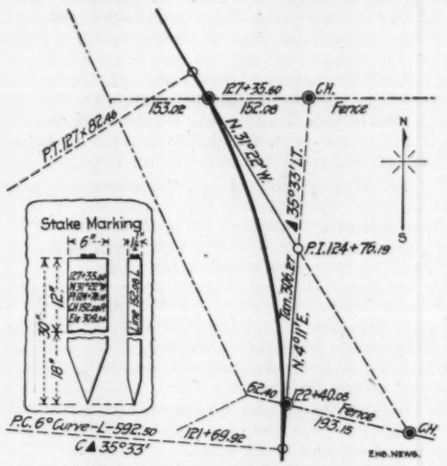
Very respectfully,

The American Mfg. Co.,
W. F. Morgan.

63-65 Wall St., New York, Dec. 21, 1905.

A New Method of Setting and Marking Preliminary Survey Stakes.

Sir: Having been interested in several preliminary railroad surveys, and having experienced some difficulty in establishing a line on the ground that would last through the era between the making of the survey and beginning of actual work, I recently tried a new method of stake setting which seems very satisfactory. Small stakes, merely large and substantial enough to last a few weeks during the time of making the survey and taking the topography, were placed every 100 ft., but at every fence line, or tree that was on the line, a flat board stake was driven. The stake was usually 6 ins. in width, 1 in. in thickness, and from 28 to 30 ins. in length. It was driven down so that about 1 ft. of it protruded above the ground, and if the fence was a wooden one the stake was nailed firmly to it. This made a reference point that would not be affected by any of the ordinary elements, and would remain undisturbed for years. The marking of this stake can best be seen in the accompanying diagram. In each case, it will be noticed, the tangent is prolonged (where a point of intersection comes between fences) to the next fence, by foresight, and referenced to the last fence passed by backsight. A point of intersection can thus be located without regard to the disturbances that may exist in the field after its first location. These stakes should be



A New Method of Setting and Marking Preliminary Survey Stakes.

marked with the best of crayon, pressed deeply, or with a graver and crayon, in which case the markings will show for years. A man should go over the line and place these stakes while the survey is in progress, marking his stakes before he starts out, getting his data from the transitman's notes.

T. G. Kitchin.

147 E. State St., Trenton, N. J., Dec. 19, 1905.

The Burning of the Twenty-third Street Ferry-Houses in New York City.

Sir: I beg leave to correct two inaccuracies in the account of the fire which destroyed the ferry-houses of the Lackawanna and New Jersey Central Railroads at West 23d St., appearing in your issue of Jan. 4. The statement that "no insulating filling was used in the hollow interior" of walls is misleading, as the principal walls, in the Lackawanna building, were filled with mineral wool.

The cause of the fire has not been positively determined; but the fire certainly did not start in "waste building material and rubbish under the floor of the Lackawanna building." The construction of the substructure would preclude the possibility of any such material being under the floor, as the latter was only a few feet above the water and supported an open crib work.

The mineral wool filling mentioned above probably retarded the spread of the flames to some extent, since the New Jersey Central ferry-house, where no wool was used, was almost totally destroyed long before the superstructure of the Lackawanna building was thoroughly on fire, and the destruction was much more complete. It did not, however, prevent the wooden studs embedded in it from burning when they once caught fire; the fibrous nature of the filling apparently admitted a sufficient supply of air to readily support combustion of the studding. The experience seems to indicate that mineral wool is not an effectual fire stop, useful as it may be as a heat insulator.

Yours very truly,

Kenneth M. Murchison.

320 Fifth Ave., New York, Jan. 8, 1906.

ALLIS-CHALMERS ELECTRIC RAILWAY EQUIPMENT: TOLEDO, PORT CLINTON AND LAKESIDE RY.

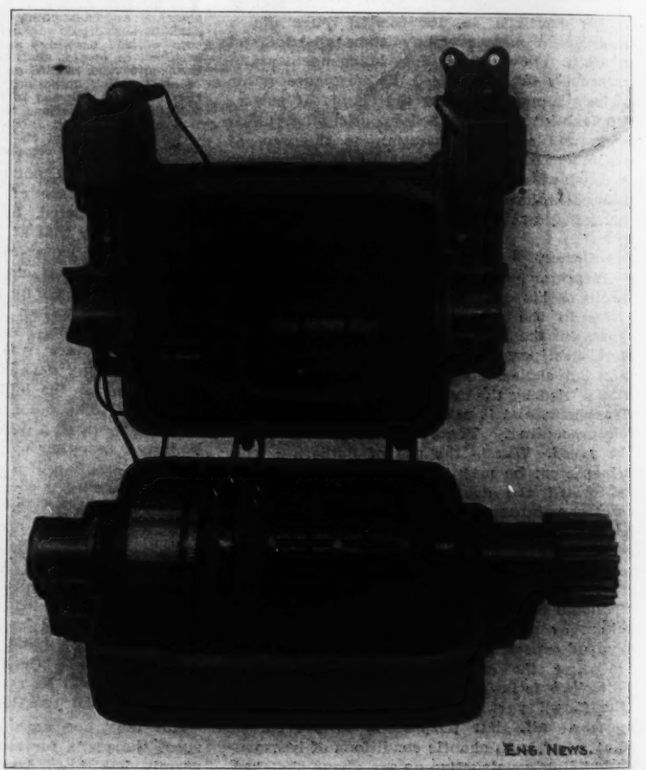
A new interurban electric railway, recently completed in Northwestern Ohio, is of special interest from the fact that it represents the entry of a new company into the field of direct-current traction equipment. The railway is the Toledo, Port Clinton & Lakeside Ry., running from Toledo, O., east about 40 miles to Port Clinton, O., and about eight miles beyond Port Clinton eastward to Lakeside and Marblehead, O. (five miles from Sandusky, on the opposite side of Sandusky Bay).

The general features of the electrical design of this line are more or less conventional. Power is generated in a 1,600-KW. power-house at Port Clinton, is transmitted as three-phase alternating current at 20,000 volts to three rotary-converter sub-stations outside the power-house, and in these sub-stations is lowered in voltage and converted into direct current at 600 volts, which is supplied to an overhead trolley wire. The car motors and controllers are of more specific interest. They are described by the manufacturers as follows:

The motors are rated at 50 HP. each, though capable of delivering a greater output without overheating. They have a continuous capacity of 45 amperes at 500 volts, showing no more than 75° C. temperature rise in shop test.

The field frame is of steel casting divided horizontally through armature and axle bearings. A liberal center distance is allowed between these bearings, so that a maximum axle of 6 ins. diameter may be used. The pole pieces are of laminated iron secured to the frame by through bolts. There are four poles, each provided with a coil which is securely held in place by the projecting tips of the pole pieces. The pole pieces are made with ventilating ducts which register with the ducts in the armature, allowing air to circulate through the pole piece and around the coil.

The armature core is built up of soft steel laminations annealed after punching. The coils are machine wound and thoroughly insulated; they fit accurately in the slots and are held down by band wires, which are well below the surface of the core. The commutator is 11½ ins. in diameter and of 4¼-in. face. It is built up of hard drawn copper bars and insulated with the best mica.



ALLIS-CHALMERS DIRECT-CURRENT RAILWAY MOTOR [BULLOCK R-50], USED ON THE CARS OF THE TOLEDO, PORT CLINTON & LAKESIDE RY.

The commutator has a wearing depth of about ⅞-in. The brush holders are of cast brass secured to a specially treated wood block. This block is in turn bolted to the end of the upper field frame, fitting in an accurately babbitted seat. Each holder is secured to its block independently of the other and carries two carbon brushes; an independent pressure finger is provided for each brush. The bearings are of cast iron with babbitt lining. The pinion end armature bearing is 3½ ins. in diameter and 2½ ins. long, and the commutator end bearing is 3 ins. in diameter and 7¼ ins. long. The axle bearings are 5½ ins. in diameter and 9½ ins. long.

Cast steel cut gears of split pattern are used. The teeth are of 3 Diametral Pitch and 5-in. face. The pinions are of forged steel, fit the armature shaft on a taper seat, and are secured by key. The gear ratio is 24 to 65. Lugs are provided on the top field frame for bolting to the suspension bar.

The controller used is of the series parallel type. The main drum makes the rheostatic and motor combination for the four motors. The reverse drum is provided with contacts for each motor and is interlocked with the main drum. A cutout switch is provided for cutting the motors out of circuit; the cutout switch can be thrown, without removing the controller cover, by using the reverse lever. A special main handle is used requiring at least a short stop at each point when feeding it. There are seven points in series and five in multiple. A magnetic blowout is used to protect the contacts. The arcing is also reduced at the open circuit position by inserting an extra section of resistance before breaking.

The equipment of the power station has the following main elements: Power is generated by two Allis-Chalmers engines, of horizontal cross-compound condensing type, which, with steam at 150 lbs., and a condenser vacuum of 26 ins., have a normal capacity of 1,280 I. HP. each. Four 400-HP. Erie water-tube boilers, arranged in batteries of two each, equipped with steel stacks, furnish the steam. The condensers are Tomlinson, of barometric type. Direct-connected with each engine is an 800-KW. Bullock alternator, which produces three-phase current at 25 cycles frequency and 375 volts' pressure. Three single-phase transformers, oil filled and water-cooled, connected in delta, raise the pressure from 375 to 20,000 volts. The outgoing high-potential lines pass through a weather-proof hood in the wall of the building, projecting about 2½ ft. outside the building, about 40 ft. above the ground; the wires pass downward through insulators in the bottom or floor of the hood to an anchorage 5 ft. below, fastened to the outside of the building, whence they lead directly to the main pole line. Inside the building the high-potential wiring is only about 25 ft. long, from transformers to hood.

In the basement of the building, directly under the transformers, is located a large steel tank of sufficient capacity to receive the entire amount of oil used in the transformers and in the reactive coils for the rotary converter. This is a precaution against fire.

Exciting current is supplied by two generating units, each consisting of a 50-KW., 125-volt compound wound dynamo, direct-connected with a high-speed simple engine. A single exciter can supply both generators.

The main power-house supplies current to its section of line by means of one 400-KW. rotary converter, taking current directly from the generator bus-bars. Space is left for a second converter of the same size.

The transmission line now being built is a single three-phase circuit, of No. 6 B. & S. copper wire. It is planned to place a second circuit later.

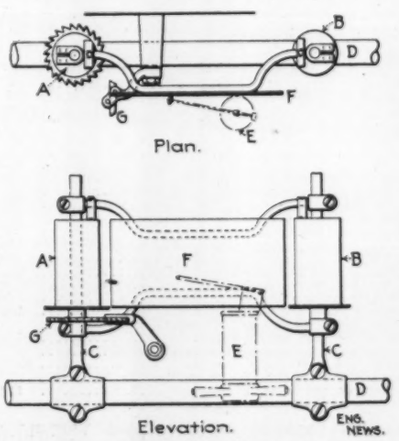
The design and construction of the system is in charge of Mr. T. B. Wickenden, Chief Engineer of the Toledo Interurban Construction Co., which is building the road. The electrical equipment of power station, sub-stations and cars, and the steam engines, were furnished by the Allis-Chalmers Co., of Milwaukee, Wis. The electrical machinery was designed and built at the Bullock works of that company, Cincinnati, O.

OFFICIAL TEST OF 7,500 HP. STEAM ENGINE FOR THE INTERBOROUGH RAPID TRANSIT CO., NEW YORK CITY.

Official tests were recently made on the Allis-Chalmers double cross-compound engines installed in the 50th St. power station of the Interborough Rapid Transit Co., New York City, for ascertaining whether the operative results would meet the requirements of the contract. The tests were made under the supervision of Mr. Frank N. Waterman, who acted as referee, and both the Allis-Chalmers Co. and the Interborough Co. were represented by several of their officials.

The power-house equipment includes nine cross-compound engines of 7,500 rated HP., direct connected to Westinghouse revolving field alternators of 5,000 KW. capacity, generating a three-phase current at 11,000 volts. According to the terms of the contract, the steam consumption should not exceed 12.25 lbs. of dry steam per indicated horse-power per hour, when indicating 7,500 HP. at 75 R.P.M., with a vacuum of 26 ins. at the low-pressure cylinders, and with a steam pressure at the throttle of 175 lbs. This rating must include all steam used by the engine, the jackets and the reheater. A further memorandum agreement, formulated by the representative engineers of each company, governed in detail the conduct of the test, this secondary agreement being necessitated by certain features peculiar to the case, involving the very essential point of the original contract.

The variation of the generator load, averaging approximately 12% in three seconds, plus or minus, presented a prohibitive impediment to the exclusive use of the ordinary engine indicator method for accurate results. Thus the only practicable method was to obtain the developed electrical horse-power of the unit, and correct this by engine friction and generator losses, as determined by subsidiary tests, these tests becoming practically of primary importance, as indicated by results of preliminary trials. The final decision was to make friction determinations by two methods, hereinafter designated and described as the electrical method and the continuous indicator method, the former to be considered decisive if checked up to within 10% by the latter.



Continuous Indicator Diagram Device.
Designed by Mr. W. L. Seabrooke, Interborough Rapid Transit Co., New York City.

Following is a description of the conduct of the test proper and the subsidiary tests, as reported by the engineer in charge of each department of the test:

ENGINE TEST PROPER.—The engine designated as No 8, being so situated as to permit unit isolation from the rest of the plant, was selected as representative of the complete installation. All steam and water mains and auxiliary lines in the unit were either entirely cut off from the rest of the house or separated by two valves and a bleeder or drip valve between. The unit as thus isolated consisted of seven boilers, the water ends of a boiler feed pump and a circulating pump, respectively, and the main engine and generator.

The following auxiliary apparatus was installed for use in the tests: four tanks, mounted in pairs upon two 20-ton scales, with a capacity per pair of 28,000 lbs. of water, for weighing the total feed water as delivered by the supply line; two reservoir tanks, connected by equalizers, inserted in the pipe line between the weighing tanks and the boiler feed pump. For the weighing of drips, leakage, etc., small scales and tanks were erected as necessary. Peabody throttling calorimeters were connected to the main line, in close proximity to the throttle, for use in case of wet steam. All gages and thermometers were carefully calibrated and standardized to the satisfaction of both parties. For the purpose of correcting for changes of level of the water in the boilers, scales graduated to tenths of an inch were placed close to each gage glass and a temporary walkway erected to facilitate readings. Floats indicated the water level in the reservoir tanks, by means of which a constant level was maintained. To eliminate the use of the calorimeters, the steam supply was maintained at a constant low degree of superheat, one boiler containing superheated coils, and this operated as desired. Vacuum was maintained at an average of 26 ins. mercury. Due allowance was made for all known leakage and drips.

Readings were taken at 15-minute intervals, an hourly graphical log also being maintained.

METER CONNECTIONS AND CALIBRATIONS.—The load on the engine was measured electrically by means of four balanced three-phase integrating wattmeters of the induction type, connected to current and potential transformers, located at the terminals of the alternator. A current transformer was in series with each of the three armature conductors and two potential transformers, connected across phases 1 to 2 and 2 to 3, respectively.

As the potential transformers were designed for use under closely defined conditions, and could therefore be accurately standardized by the makers, their ratio, which is 100 to 1, was assumed to be correct. In the case of the current transformers, however, where the ratio is subject to change, due to changed secondary resistance, it was considered desirable to re-check the ratios, which was done as follows:

One phase of the generator was short-circuited through a standard Kelvin ampere balance in series with the current transformer in phase 1, and a portable ammeter, which was substituted for the regular switchboard ammeter, in the secondary side, thereby securing accurate measurement of the secondary current without altering the secondary resistance appreciably; also all other instruments having a current winding, which were to be used for the test, were included in the circuit. The generator was then run at full speed and the excitation adjusted to generate full load current (263 amps.), in the armature. During this period 20 readings of primary and secondary current were taken simultaneously by means of telephonic communication between the readers of the Kelvin balance and secondary ammeter. From these corrected readings the true ratio of transformation was calculated. It can be seen that this method of test, which is made under operating conditions, will make a correction for any error due to inductance in the secondary circuit caused by running the current transformer leads in iron pipes, which could not be corrected for in the original manufacturer's ratio test. This test was repeated for phases 2 and 3 under similar conditions.

The correction for readings on the four balanced three-phase wattmeters were calculated from the corrected transformer ratios and the meters calibrated and adjusted by comparison with Weston standard wattmeters, the calibration of which is mentioned below.

In calibrating the instruments, a Kelvin ampere balance, used for ratio tests, was compared with a potentiometer and standard resistance. The ammeter for secondary current was compared with the current dynamometer, standardized by means of the potentiometer and standard resistance. The current transformer for friction trials was checked by comparison with a Kelvin ampere balance. Standard indicating wattmeters, used for calibrating integrating wattmeters, were checked by comparison with Weston laboratory standard voltmeter and potentiometer and standard resistance. Weston standard portable shunt and millivoltmeter were checked by comparison with potentiometer and standard resistance. The work of calibrating the standards was performed by the Electrical Testing Laboratories of New York in all cases, and, in addition, by comparison

with the Interborough Rapid Transit Co.'s own standards, whenever possible, in all of which cases the same agreed within the limits of precision of the instruments tested.

The meters were connected as follows: One in the secondary of each of the current transformers in phases 1 and 3, respectively, and two in that of phase 2, the object of this method being to show by the readings of the meters in the three phases that the load was balanced; while the object of the two meters in a single phase was to furnish a continual check on the calibration of the meters. It was found that all meters agreed within their limits of precision, and results were therefore calculated from the average of the readings of the four meters, which was taken as the true output of the generator in K.W.H.

FRICTION DETERMINATION AND ELECTRICAL LOSSES (ELECTRICAL METHOD).—The combined losses in the unit were ascertained by driving the generator as a synchronous motor with the engine trailing and measuring the watts input, which, it can be seen, would consist of combined friction and windage, I^2R losses and iron losses. As this input was too small to be measured accurately by means of the four load meters, a special meter, with its standardized current transformer, was used. The generator could not be run as a motor for periods longer than five minutes, because of the difficulty in lubricating the engine cylinders. This was not long enough to give a dial reading on the wattmeter, so, during the short run, it was read by counting the revolutions of the wattmeter disk, timing the same with two chronograph watches reading to tenths of a second and the mean KW. figured by the usual calibrating formula. During this period the field current was held at that value corresponding to full load excitation in order to make the iron losses the same as at full load, and was read on a Weston standard portable ammeter. The armature volts and amperes were also read at 10-second intervals in order to obtain the power factor, which, due to the overexcitation of the field at such small load, was low, averaging for the several trials 18.5%, with a leading current. As the meter used for this test was calibrated at a power factor of 1.0, it was necessary to check it on low values, and readings were therefore taken with a leading current at 10 points from 0.1 to 1.0, and a curve plotted, showing the error, which curve was used to correct all readings taken on the friction trials. To this corrected input, as the armature current was below full load value, must be added the difference between the I^2R losses at the observed value and that corresponding to full load current. From the above, the output of the generator, plus the input to the generator motorized, plus the difference betwen the I^2R loss at motor current and the same at full load current, equals the total load on the engine in KW.

FRICTION DETERMINATION BY CONTINUOUS INDICATOR METHOD.—For this purpose a continuous indicator was designed by Mr. W. L. Seabrooke, of the Interborough Co., which instrument solved the problem of indicator application to the engine. This instrument, as shown in the cut, consists of two drums "A" and "B" turning freely on spindles "C"—"C", which in turn are mounted firmly on the mandrel "D." These assembled parts are given a reciprocating motion, corresponding to the stroke of the engine, in front of the indicator "E," and take the place of the usual rotary recording drum of the indicator. A strip of paper, winding on "A" from "B," passes over the plate "F," thus presenting a flat recording surface. A complete diagram is taken for each stroke, and as the back pressure line is traced the ratchet "G" makes contact with the toothed wheel under the drum "A," causing the recording paper to be advanced the distance between successive cards for the diagram of the next stroke. The ratchet "G" is fixed, but can be adjusted to make the advancement of the card at any point or section of the stroke. As the back pressure line is usually straight, no error is introduced and the cards present the same appearance as if taken singly. The operation is automatic and records a card for each revolution to the extent of the paper supplied by the drum "B."

Using this device, two sets of indicator cards were taken on the engine running empty—one for a period of two minutes, with an exciter current at 165 amperes, and the other for a period of one and one-half minutes, without excitation current.

LEAKAGE TEST.—A leakage test of boilers and boiler feed and steam lines to the engine throttle were made 36 hours subsequent to the official engine trial, said test being of 24 hours' duration. In connection therewith water was weighed and fed to the boilers by way of the reservoir tanks, as in the engine test. Due allowance was made for all known leakage and drips, and correction made for change in boiler level.

Results of Friction Trials (Electrical Method.)

1. Volts armature by switchboard meter	10.510
2. Amps. armature by switchboard meter	119.6
3. Amps., Field by Western Standard	202.2
4. Kilovolt-amperes armature $\sqrt{3} \times$ (No. 1) $\times$ (No. 2)	2.170
5. Power factor (No. 6) $\div$ (No. 4)	18.55
6. KW. Input, $\frac{427.4}{106.1} \times 100$	402.5
7. I^2R on test $(119.6)^2 \times$ (No. 11), KW	4.12
8. I^2R at full load $(263)^2 \times$ (No. 11), KW	18.92
9. Difference between (No. 7) + (No. 8), KW	14.8
10. Total Losses, (No. 6) + (No. 9), KW	417.3
11. Resistance of Armature at 30° C., ohms	.2877

(This is the calculated resistance for the three phases.)

The value, 417.3 KW., is therefore added to all full load output readings to obtain total load on the engine.

Results of Friction Trials (Continuous Indicator Method.)

1. With exciter current, generator unloaded, I.HP.	580.78
2. Without exciter current, I.H.P.	432.7

Results of the Engine Trial, with averages, follow:

Duration, hrs.	15
Preliminary operation on load, hrs.	2
Load (Switchboard reading), KW.	5079.2
Friction and Electrical Losses, KW.	417.3
Total Load, KW.	5496.5
I. H. P.	7365.5
R. P. M.	75.02
Steam Pressure, lbs. (gage)	175.18
R. H. Receiver Pressure, lbs. (gage)	19.1
L. H. Receiver Pressure, lbs. (gage)	19.27
Vacuum, ins.	26.02
Barometer, ins.	30.5
Temp. Injection Water, deg. F.	42.36
Temp. R. H. Discharge, deg. F.	74.05
Temp. L. H. Discharge, deg. F.	77.38
Water per hour, lbs.	89,906
Weighed leakage per hour, lbs.	512
Leakage per hour (Leakage Test), lbs.	1,470
Boiler Level Correction per hour, lbs. (high)	60
Net water per hour, lbs.	87,864
Correction for superheat, %	.28
Equivalent dry steam per hour, lbs.	88,110
Dry steam per KW. H. (Switchboard)	17.34
Dry steam per I. H. P (Engine)	11.95

A HIGH VOLTAGE ELECTROSTATIC VOLTMETER OPERATING IN OIL.

The use of oil as an insulating medium has been adopted by the Westinghouse Electric & Mfg. Co., in a new high-tension electrostatic voltmeter, which is being placed on the market. The high pressures, widely used in electrical testing and experimental work, make it difficult to secure a voltmeter which is accurate, compact, dead-beat and consumes a negligible amount of energy. It is claimed that, with the working parts operating in a bath of oil, all these requisites are obtained.

The operating elements of this instrument are immersed in a special grade of oil contained in a metal lined wooden case with an insulated cover. The metal lining acts as a screen to prevent outside fields or influence from affecting the meter. The insulation is one of the most important parts of an instrument of this type, and the advantages derived from the use of oil are summarized as follows by the manufacturers:

(1) The distance between the operating elements may be greatly lessened, thereby reducing the size of the instrument.

(2) The actuating forces are greatly increased, due to the smaller distances between active parts and the high specific inductive capacity of the oil.

(3) The reduction in distance between working parts of the meter makes possible a better form of scale.

(4) The oil acts as a damper and makes the instrument nearly dead-beat and easy to read.

(5) The oil buoys up the moving element, thus removing practically all weight from the bearings.

The arrangement and relative position of the parts of the meter are shown in the diagrammatic sketch, Fig. 1. The curved plates B 1 and B 2 are of such a shape and so arranged with respect to the moving element that a deflection in a positive direction shortens the gap between it and the plates. The charges induced on the two extremities of the moving element are of such a nature that they exert forces of attraction on the charges on the plates, which bring about such a movement. The turning of the moving element is restricted by a spring and the deflection of the pointer is read on the scale. The condensers C 1 and C 2 are in series with other parts of the instrument, one plate of each being metallically connected to a curved plate, and the other to a terminal. The instrument may be operated with

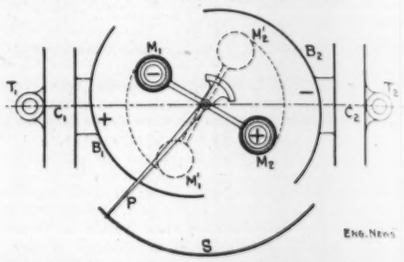


Fig. 1. Diagram of the Westinghouse Electro-Static Voltmeter.

either or both condensers short circuited, thus giving a wide range to the meter.

The curved plates, with the condenser plates attached, are supported from the insulated cover by means of grooved posts of insulating material. The separate condenser plates are supported in a similar manner. As all parts are firmly fastened to the same base, they are held in constant relation to each other, and no error can result due to disarrangement of parts. The height of the oil in the case, together with the long paths over the suspension posts, greatly reduce leakage between the plates. The horn-shaped terminals extend to the same distance below the oil as the suspension posts, and are also grooved so as to prevent leakage over their surface.

The bearing springs and adjustments are similar to corresponding parts of Westinghouse standard indicating instruments. The cylindrical parts of the moving elements are hollow, and so proportioned that the buoyant effect of the oil removes almost all weight from the bearings, thereby eliminating friction and wear. The scale

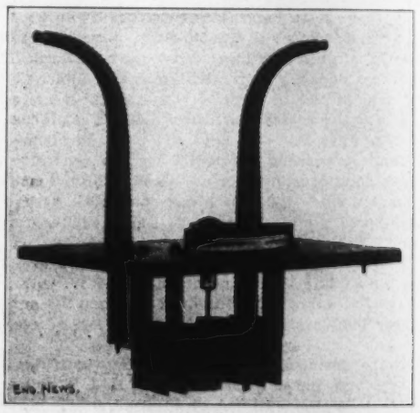


Fig. 2. Westinghouse Electro-Static Voltmeter with Cover Removed.

over which the pointer passes is placed on an edgewise cylindrical form similar to the scale of an edgewise switchboard instrument, and the reading may be taken from a safe distance. With the exception of the glass window through which the scale is read, the cover over the pointer is all metal, and acts as a screen to prevent external static fields from affecting the pointer. Instruments of this type may be obtained for potentials as high as 200,000 volts. The one shown in Fig. 2 may be used for voltages up to 100,000 volts with the condensers in circuit, or for approximately 50,000 or 25,000 volts with one or both condensers short circuited. The case is 22 ins. long, 18 ins. wide, and 15¼ ins. high, with terminals projecting 18 ins. above the case.

AN INVESTIGATION OF CURRENT PRACTICE RESPECTING SWITCH TARGETS AND LIGHTS.

The practice of various railways as to the target and lamp equipment of switchstands was investigated a short time ago by Mr. Joseph O. Osgood, M. Am. Soc. C. E., Chief Engineer of the Central R. R. of New Jersey. He sent a series of enquiries to 50 railways, and the full list of replies has been published in Bulletin No. 69 (November, 1905) of the American Railway Engineering and Maintenance of Way Association. These replies are summarized below. As a result of this investigation, the Central R. R. of New Jersey has adopted a single target, for the "danger" (switch open) indication only. The target is of No. 8 or No. 10 iron, oblong, 24 × 9 ins., with semicircular ends, and its top is 6 ft. 8½ ins. above the ties. The replies to the enquiries noted above may be summarized as follows:

1. On double track, 43 roads use targets and lamps on both facing and trailing switches; 4 roads use them on facing switches only. In some cases lamps are omitted at trailing switches and crossovers at stations.

2. As to the use of single or double targets (giving an indication for each route), 38 roads use the double and 12 use the single ("danger" only) targets. Of the 38 roads using double targets, 8 use the same shape for both, but on 4 of these the two blades are set at different angles, so that the indication is by the form as well as color of the blade; 29 roads use two blades of different shapes; 1 road has both blades the same shape for facing switches, and of different shapes for trailing switches.

3. As to the indication of the position of the switch by the target, 33 roads report that the position is indicated by the shape as well as the color of the target; in 4 of these cases the blades are of the same shape, but are set at different angles to the rod, or support.

4. As to the use of a switch target in the form of a semaphore blade, 11 roads use this form (but it is experimental on three of these); 39 do not use it, but four of these may do so in the future.

5. As to the use of a distant signal interlocked with the switchstand of a facing switch, 31 roads use such a signal and 18 do not, but 6 of the latter either intend to use them or have a few already in special places.

6. As to the use of a high tripod switchstand, so that the target can be seen over freight cars, 23 roads use it, but on 7 of these it is not general; 27 roads do not use it, but 4 of these may do so in the future.

7. All the 50 roads report that they use the lamp signal to indicate safety when the switch is closed; 28 roads use a white light to indicate safety, 21 roads use green, and 1 uses both white and green.

8. As to whether a white light is advisable as a fixed signal to indicate safety; 11 roads favor white, 34 roads are opposed to it, 4 are noncommittal, and 1 has the matter under consideration.

DEPTH OF THREAD OF MEAN VELOCITY IN RIVERS.

By F. W. Hanna.*

In the measurement of the flow of rivers it is often assumed that the thread of mean velocity lies at approximately 0.6 of the total depth from the surface, varying for extreme cases between the limits of 0.5 and 0.7. There seems to be a general impression that this assumption is not capable of theoretical demonstration. It is, however, a rational deduction from a general law of flow of water in rivers—namely, that the vertical velocity curve is sensibly a parabola whose axis is parallel to the water surface and either coincides with it or lies below it. This axis is usually situated between the surface and one-third of the water depth, so that the maximum velocity filament is comprehended between these limits.

If d equals the total depth of water; ad, the depth of the thread of maximum velocity below the surface; b, the unitary complement of a, and y the depth of the mean thread of velocity; then it may be easily shown by the theory of mean values that,

$$y = ad = d\sqrt{\tfrac{1}{3}(a^2 + b^2)}.$$

By assigning values to a between 0 and 1-3 and substituting them with simultaneous values of b in the above equation, there results the following table:

Maximum velocity depth.		Mean velocity depth.
When a = 0		y = 0.58d.
" " = 1/10d,		" = 0.59d.
" " = 3/20d,		" = 0.60d.
" " = 1/5 d,		" = 0.62d.
" " = 1/4 d,		" = 0.63d.
" " = 3/10d,		" = 0.65d.
" " = 1/3 d,		" = 0.67d.

From this table it may be inferred that if the maximum velocity thread lies above one-fifth the depth, the assumption of 0.6 depth agrees very closely with the theory. In most of the ordinary streams that are neither very shallow nor very deep this is the position of the maximum thread under usual conditions. Where a stream is very deep the maximum thread of velocity generally lies at a greater proportional depth, and the thread of mean velocity, therefore, lies at a greater depth, which is verified by theory. If a stream is very shallow, and has additionally a rough bed, the friction effect on the flow is so proportionally large as to upset the parabolic law near the bottom, thus causing the mean thread to rise above the requirement of theory. In extreme cases this disturbance is sufficient to cause the mean thread to rise to 0.5 of the depth.

The foregoing theory serves to show that the single point method has a rational basis, but it also demonstrates that it must be used with circumspection. The fact that the location of the mean thread of velocity is dependent upon the location of the maximum thread, which is variable in situation, is important. A study of the position of the maximum thread of velocity as well as that of the water depth, channel width and bed roughness, is essential to the intelligent use of the single point method in determining the mean velocity in a vertical plane.

*Engineer, U. S. Reclamation Service, 1333 Park Road, Washington, D. C.

NOTES FROM THE ENGINEERING SCHOOLS.

TRINITY COLLEGE, HARTFORD, CONN.—A course in sanitary engineering, modeled largely after that given at the Massachusetts Institute of Technology, has been announced, to begin with the college year 1906-7. Chemistry, biology and hygiene will play a large part in the course.

PURDUE ALUMNI ASSOCIATION, NEW YORK CITY.—On the evening of Dec. 18 representatives of the alumni of various departments of Purdue University, living in or near New York, met in that city and organized an alumni association, with a charter membership list of about one hundred men. Meetings will be held on the second Wednesday of each month. Mr. P. E. Fansler, of J. G. White & Co., 49 Exchange Place, New York City, was elected as President, and L. M. Grant, of the C. W. Hunt Co., 45 Broadway, New York City, Secretary-Treasurer.

THE EFFECT OF FINE GRINDING ON THE TENSILE STRENGTH OF PORTLAND CEMENT.

The eleventh annual report of the Boston Transit Commission, just issued, contains a table showing results of tests to determine the effect of fine grinding on the strength of Portland cement. The cement tested was Vulcanite, and it was found that 76% passed through a No. 200 sieve, containing approximately 40,000 meshes per sq. in. The table is reproduced herewith. The tests make it very clear that cement is greatly weakened by the coarse particles of unground clinker:

TESTS TO SHOW THE EFFECT OF FINE GRINDING UPON THE TENSILE STRENGTH OF PORTLAND CEMENT BRIQUETTES.

Kind of Cement.	Proportions.	Age of Briquettes.	No. of Briquettes.	Average Tensile strength. Lbs.	Relative Strength in Percentages.	% Gain in Strength from the 7 to 28 Day Period.
Vulcanite, as taken from bag	1 part cement. 3 parts standard quartz sand, by weight.	7 days	3	343	100	....
" residue on No. 200 sieve		7 "	3	29	8.5	....
" that passed through No. 200 sieve		7 "	3	489	142.5	....
" as taken from bag		28 "	3	460	100	34
" residue on No. 200 sieve		28 "	3	110	24	38
" that passed through No. 200 sieve		28 "	3	561	122	15

THE FAILURE OF AIR-BRAKES TO WORK on six coaches which were being shunted on to track No. 11 at the Grand Central Depot, New York City, Dec. 7, resulted in a rather unusual accident, in which one person was killed. As the Montreal Express was being made up, six empty Pullman cars were being switched on to the track in question, and, as was the usual custom, the engine gave the cars sufficient impetus to carry them to the end of the track, and was then cut off. In such cases, one of the train-crew is stationed on the forward platform and controls the speed of the cars by the hand brakes or when the momentum is too great, a goose-neck or safety-device, which controls the air-brakes by releasing the air, can be used to bring the train to a sudden stop if necessary. The air tanks of the cars are full before the engine is detached. In the case in question the cars were traveling approximately ten miles per hr., and when the brakeman attempted to release the air by means of the goose-neck, it failed to work. Whether the angle-cock in the train-pipe had not been opened, or the air tanks were without air, has not been definitely ascertained. With undiminished speed the six cars crashed into three empty day coaches, standing on the end of the track against a bumper, driving the last one, clear of its trucks, through the iron fence, across the concourse, and was finally stopped by contact with the brick wall of the station. One man was pinned between the end of the car and the wall, and was almost instantly killed, while several others narrowly escaped serious injury.

A PUBLIC HEATING SYSTEM has been established at Chatham, Canada, by the Chatham Steam Heating Co., using the exhaust steam from the power station of the Chatham, Wallaceburg & Lake Erie Ry. About a mile of mains has been laid, and several churches, schools, residences, offices, etc., are being heated. The iron pipe is wrapped with asbestos enclosed in a tin pipe, between which and the outer sheathing of creosoted wood is an air space. The pipe is laid from 4 to 5 ft. deep, and has traps at intervals for water of condensation, which is discharged into the sewers.

LARGE SINGLE-PHASE ELECTRIC LOCOMOTIVES will be used to draw trains through the Sarnia tunnel of the Grand Trunk Ry. under the St. Clair River. The locomotives will be of 62 tons weight, all on drivers, and will have three axles fitted with 62-in. wheels. The power equipment consists of three 250-HP. single-phase series-wound motors, each connected by a pair of 18 to 95 gears to its axle. A rigid frame of cast steel, outside of the wheels, contains the axle boxes and carries the draft gear. Equalizers distribute the weight. For collecting current the locomotive will be fitted with pneumatically-operated diamond-frame trolleys. Catenary suspension of the trolley wire is to be used outside the tunnel. The trolley current is 25-cycle alternating, at 3,000 volts pressure. The locomotives will be equipped for multiple-unit control. Each locomotive will have an effective drawbar pull of 25,000 lbs. at the speed of 10 miles per hour on a 2% grade. Six such locomotives will be used, according to present plans, and two or more may be coupled together, so that a train as heavy as the draft gear will stand can be hauled through the tunnel. The tunnel itself is about 6,000 ft. long, and is single-track. The electric section will be about 19,000 ft. long, and will be double-track except in the tunnel itself. The electrical installation has been contracted for by the Westinghouse Electric & Mfg. Co., of Pittsburg, Pa. Mr. B. J. Arnold, of Chicago, Ill., is engineer for the St. Clair Tunnel Co. in the work.

ELECTRIC POWER from the power plant now being built at Lockport, Ill., on the Chicago Drainage Canal, can be utilized in many ways by the city of Chicago, according to a recent report by John Ericson, Consulting Engineer; Wm. Carroll, City Electrician, and J. M. Patterson, Commissioner of Public Works. About 15,000 HP. can be delivered at the substation in Chicago, and part of this will be available by January, 1907. There are now 6,700 electric street lamps, and it is proposed to increase these to 29,000, which would require 21,000 HP. for 11 hours per day. For the day load, the water-works pumping stations would require 14,000 HP., but to make this available it would be necessary to instal entirely new plants in place of the present steam engines and pumps. Attention is also called to the fact that power for the water-works must be constant and reliable, while

with a water power plant there is liability of occasional shutting off of the power due to anchor ice, accidents to the power plant or transmission lines, etc. There are also several sewage pumping stations, requiring from 16 HP. to 300 HP. each, while each of the 50 city bridges requires about 125 HP. for operating, lighting, pumps, signals, etc. As to electric traction, the pending ordinances call for 1,582 double-truck cars and 851 single-truck cars to be in operation within three years, and these (with an allowance for a certain proportion out of service and under repair) would require some 95,000 HP.

The conclusion of the report is as follows:

All the power that can be developed at both the power plants that the Sanitary District proposes to install can be utilized for 19 or 20 hours out of the 24. The surplus power developed during the remaining four or five hours could be stored.

Assuming that the power from the proposed water power plant will be obtained at a price that will bring the cost below that of power generated by steam driven plants and sufficient funds for necessary installations are appropriated, we beg to emphasize the following:

First. The most desirable use for municipal purposes of the power now being developed at Lockport would be for the operation of municipal street railways, which can use all the power that the sanitary district can furnish for 24 hours each day.

Second. For the lighting of the city's streets and municipal buildings, provided a disposition can be made of the power during such hours when lighting is not required. This may be done if the city is given the right to dispose of power for commercial purposes during the day.

Third. Sewage pumping stations, bridges, and other minor utilities may be equipped for electrical operation, but would not to any appreciable extent serve to utilize during the day time the released power used for electric lighting during the night.

PERSONALS.

Mr. Elliott L. Brown has opened an office for the practice of Architecture in Yonkers, N. Y.

Mr. G. H. Kimball, M. Am. Soc. C. E., has resigned his position as Chief Engineer of the Chicago & Alton Ry. Co.

Mr. John A. Topping has resigned his position as President of the American Sheet & Steel Plate Co. in order to assume other business obligations.

Mr. James P. Morrissey, City Engineer of Dunkirk, N. Y., has been appointed County Engineer and Surveyor for the County of Chautauqua, New York.

Mr. Hugh J. Gallagher, U. S. A., who has been connected with the Isthmian Canal Commission, as Purchasing Agent, has been transferred to Manila, P. I.

Mr. W. H. McGrath has been appointed General Manager of the Houghton County Street Railway Co. and the Houghton County Electric Light Co., of Michigan, in place of Mr. A. W. Leonard.

Mr. Clifford A. Tinker has resigned his position as assistant to the Town Engineer of Westfield, Mass., and opened an office in the Post-Office Building in that town for the general practice of civil engineering.

Mr. George F. Maddock, M. Am. Soc. M. E., has severed his connection with A. L. Ide & Sons, Springfield, Ill., as General Superintendent, and will open a general engineering office at 824 Marquette Bldg., Chicago, Ill.

Mr. W. F. Steffens, Assoc. M. Am. Soc. C. E., has been appointed Engineer of Bridges and Buildings of the South and Western Ry. Co., Lick Creek & Lake Erie R. R. Co. and the Carolina Co., with office at Bristol, Va.-Tenn.

Mr. A. N. Johnson has resigned his position as Highway Engineer of the Office of Public Roads, U. S. Department of Agriculture, and has been appointed State Highway Engineer of Illinois by the Illinois Highway Commission, with headquarters at Springfield, Ill.

The new Sewerage Commission of Baltimore, Md., have announced new appointees, as follows: Mr. Frank T. Daniels, Drafting Engineer, salary $2,100 per yr.; Mr. Herbert W. Knight, Central Office Engineer, salary $2,100 per yr.; Mr. C. A. Emerson, Jr., Chemist and Bacteriologist, salary $780 per yr.

Mr. Charles W. Whittle will succeed Mr. August E. Christhilf as Engineer-in-Charge of the department for the gathering and tabulation of information regarding underground pipes, mains, etc., of the City Engineer's Office, Baltimore, Md. Mr. Christhilf will become Chief Engineer of the Commission for opening streets.

Mr. J. E. Zalles is Secretary of the Commission for the projected Bolivian National Ry., and is not Chief Engineer as was wrongly stated in our last issue. All communications pertaining to the business of this Commission should be addressed to him. Mr. W. L. Sisson has been removed from the position of Chief Engineer.

Mr. Robt. L. Lund, Assoc. M. Am. Soc. C. E., has become Consulting Engineer of the Roberts, Johnson & Rand Shoe Co., of St. Louis, Mo. His former business as Consulting Engineer in Little Rock, Ark., will be carried on by his brother Mr. Alfred M. Lund and Mr. Philip B. Hill under the firm name of Lund & Hill.

Dr. N. M. Hopkins, Professor of Chemistry at the George Washington University, Washington, D. C., has been appointed Chief Electrical Engineer, Bureau of Yards and Docks, U. S. Navy, in charge of the electrical and mechanical engineering work at the various navy yards. The position carries with it a salary of $5,000 per annum.

Dr. Gilbert J. Fowler, Consulting Chemist to the Rivers Department of Manchester, England, and for some years Superintendent and Chemist of the Manchester Sewage Works, started for Calcutta, India, on Dec. 26. He has been engaged by the Government of Bengal on sewage disposal questions, primarily in regard to the jute mills on the Hooghly River, the westernmost channel of the Ganges, at its delta.

Mr. Henry C. Ebert, assistant to the Third Vice-President of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., has resigned his position to become President of the Cincinnati Car Co. and Vice-President of the Ohio Traction Co. Mr. Ebert has been with the Westinghouse Co. for the past 15 years, during which time he has occupied the positions of Superintendent of Construction, Chief of the Correspondence Department and Assistant Manager of Works.

Obituary.

Robert R. Stannard, President of the Blake & Johnson Mfg. Co., makers of machinery, died at his home in Waterbury, Conn., Jan. 3.

Major William C. Petty, owner and manager of the Carthage R. R., extending from Cameron, N. C., to Hallison, N. C., died at his home in Carthage, N. C., recently.

Charles S. Guthrie, Chairman of the Republic Iron and Steel Co., died at Gibsonville, S. C., Jan. 3. Mr. Guthrie was the organizer and first president of the American Steel Hoop Co.

Herbert B. Blair, Topographer in the U. S. Geological Survey, died at his home in Washington, D. C., Dec. 29. Mr. Blair was first employed as a Topographic Aid on the Kentucky Geological Survey.

Mr. C. R. Bellamy, Assoc. M. I. C. E., Manager and founder of the Liverpool, Eng., tramways system, died Dec. 23. Mr. Bellamy was 49 years of age, and in his early life was Gas Engineer to the Liverpool Corporation.

Mr. William J. Lewis, founder of the Oliver Iron and Steel Co., which was originally the Lewis, Oliver & Philips Co., died at Pittsburg, Pa., Jan. 3. Mr. Lewis invented the first machinery for making nuts and bolts and was credited with numerous inventions in iron and steel.

Charles J. Joly, Royal Astronomer of Ireland, died recently. Prof. Joly was Professor of Astronomy at the University of Dublin, a Trustee of the National Library of Ireland, President of the International Association for Promoting the Study of Quaternions and Allied Systems of Mathematics, Secretary of the Royal Irish Academy, and a Fellow of the Royal Astronomical Society.

J. H. Vogel, Chief Engineer of the Birmingham & Atlantic R. R., died at Birmingham, Alabama, Dec. 19, after undergoing an operation. Among the positions held by Mr. Vogel were Assistant to the famous Italian Hydraulic Engineer, Mr. Turretini, in the erection of the Power Plant at Niagara Falls, Engineer with the Westinghouse Electric Co., and Consulting Engineer in Mexico. He was of German birth and received his education at Geneva and the Polytechnichum at Zuerich.

Col. Eugene E. McLean, for the past twenty-five years Chief Engineer in the Comptroller's Office, New York City, died Jan. 5, at his apartments, 353 W. 57th St. Col. McLean was a graduate of West Point with the class of '42, of which he had been for some time the sole surviving member. He served as a lieutenant during the Mexican War, and resigned from the U. S. Army at the outbreak of the Civil War to become aide-de-camp to Jefferson Davis. In his work as a civil engineer he had charge of the laying out of Central Park.

Dr. Otto A. Moses, a geologist and chemist, died at 72 W. 35th St., New York City, Jan. 3. Dr. Moses was of American birth, but received his education at the University of Leipsic. He started business as a mechanical and electrical engineer and was largely instrumental in the introduction of the Edison inventions in Europe. He later became State Geologist of South Carolina, and for several years had general supervision of the phosphate works. Dr. Otto was the founder of the Hebrew Technical Institute, Stuyvesant St., New York City, for the free scientific education of poor Hebrew boys.

ENGINEERING SOCIETIES.

COMING MEETINGS.

IOWA ENGINEERING SOCIETY.
Jan. 10-12. Annual meeting at Des Moines, Ia. Secy., B. J. Lambert, 24 North Clinton St., Iowa City, Ia.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17 and 18. Annual meeting at the Society House, 220 West 57th St., New York City. Secretary, C. W. Hunt, address as above.

NORTHWESTERN CEMENT PRODUCTS' ASSOCIATION.
Jan. 17, 18, 19. Annual convention at Minneapolis, Minn. Secy., F. H. Chapin, 10 N. Third St., Minneapolis, Minn.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 17, 18, 19. Annual meeting at Rockford. Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago.

INDIANA ENGINEERING SOCIETY.
Jan. 18, 19, 20. Annual meeting at Indianapolis. Secy., C. C. Brown, Commercial Club Building, Indianapolis, Ind.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21. Annual meeting at South Bethlehem. Secy., R. W. Raymond, 99 John St., New York, N.

THE FARADAY SOCIETY.—The ordinary meeting was held Dec. 12, at the Institution of Electrical Engineers, 92 Victoria St., S. W., London. Papers were presented by Mr. J. Swinburne and Dr. G. Rudorf, on "The Physics of Ore Flotation," and by Professor A. K. Huntington, on "The Concentration of Metalliferous Sulphides by Flotation." These papers are theoretical discussions on the separation of ores from the gangue or non-metallic earthy matter with which they are generally closely allied in nature. Professor J. Walker, F. R. S., contributed a paper on "The Ions of Pure Water."

WESTERN SOCIETY OF ENGINEERS.—At the annual meeting in Chicago on Jan. 2 the election of officers was announced, as follows: President, B. J. Arnold; Vice-Presidents, W. L. Abbott, Andrews Allen and Dugald Jackson; Treasurer, A. Reichmann; Secretary, J. H. Warder. At the dinner following the meeting, the first address was made by the retiring president, Mr. E. C. Carter, while the new president, Mr. B. J. Arnold, gave an address, describing the new terminals and electric traction system of the railways entering New York city, illustrated by stereoptican views. Other addresses were as follows: "Ownership of Public Utilities," L. E. Cooley; "The Engineer in the Law," Isham Randolph; "The Contracting Engineer," Onward Bates; "The Development of University-Trained Engineers," Prof. D. C. Jackson, and "Electrical Communication," S. G. McMeen.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The General Electric Company, in view of the great importance and utility of the United Engineering Building, as a home and center for the engineering professions and arts, has made a contribution of $25,000 to the land and building fund of the American Institute of Electrical Engineers. President C. A. Coffin, of this company, who takes a warm personal interest in the matter, has also sent his own check for $5,000. The committee, which had already received gifts and pledges amounting to nearly $70,000, is greatly encouraged by this generous support of its work. The fund is now, with other new contributions well over $100,000, and with renewed energy the committee has begun its canvas of the field with the object of securing the second necessary $100,000. About 600 members have already subscribed to the fund, and the committee expects to have no difficulty in at least doubling this number. It has just issued to the whole membership a handsome pamphlet, illustrating and describing the new building in course of erection in New York city, and detailing the steps that have been taken by the associated engineering bodies to give effect to Mr. Carnegie's original gift.

WASHINGTON SOCIETY OF ENGINEERS.—At the recent meeting of this society for organization, mentioned in our issue of Dec. 28, Mr. W. A. McFarland, Superintendent of the District Water Dept., of Washington, D. C., gave a very interesting description of the local water distributing plant and system. Mr. McFarland said in part, as quoted in the "Washington Evening Star":

The existence of a very large amount of weak and defective pipe throughout the older part of the city makes it undesirable at the present time to carry pressures above 60 lbs. or 138 ft. Even with the pressures from 40 to 50 lbs., about sixty of the old mains burst when the high service was first put in use.

As the District varies in elevation from a few feet above tide level to 420 ft., the system is necessarily divided into a number of separate services. The several service areas are: First, the gravity or low-service area, comprising that part of the city having an elevation of 70 ft. or less above mean tide; this is supplied by gravity from the filter plant, to which the entire supply for the District is pumped. Second, the first high pressure, between 70 and 140 ft., supplied by direct pumping without the use of a reservoir. Third, the second high service, between 140 and 210 ft., supplied by pumping in connection with the Brightwood reservoir, a double basin at an elevation of 276 ft. and with a capacity of 35,000,000 gallons. Fourthly, the third high service, between 210 and 350 ft., similarly supplied in connection with the Reno reservoir, located near Tenleytown, at an elevation of 423 ft., and having a capacity of 4,000,000 gallons; and, finally, the fourth high service, a small area in and about Tenleytown, too high to be well served from the Reno reservoir, supplied from special pumps.

Mr. McFarland showed by means of diagrams that the consumption of water between 2 and 4 o'clock in the morning was greater than there was any legitimate use for. Continuing, he said:

Data obtained from pump records, pitometer measurements and from a number of complete analyses made some years ago by means of the Deacon meter all indicate that not less than 75% of the water coming into the city serves no useful purpose.

Pictures of the new District pumping station, which has been in use about two years, showing the economical arrangement of the boilers and coal-handling apparatus, were thrown on the screen. Also pictures of the 20,000,000-gallon engines and the Brightwood reservoir, in the process of construction, were shown.